

# The Critically Endangered White-bellied Heron



Royal Society for Protection of Nature  
Thimphu, Bhutan



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*Cover photograph : Yeshey Dorji, Freelance Photographer*



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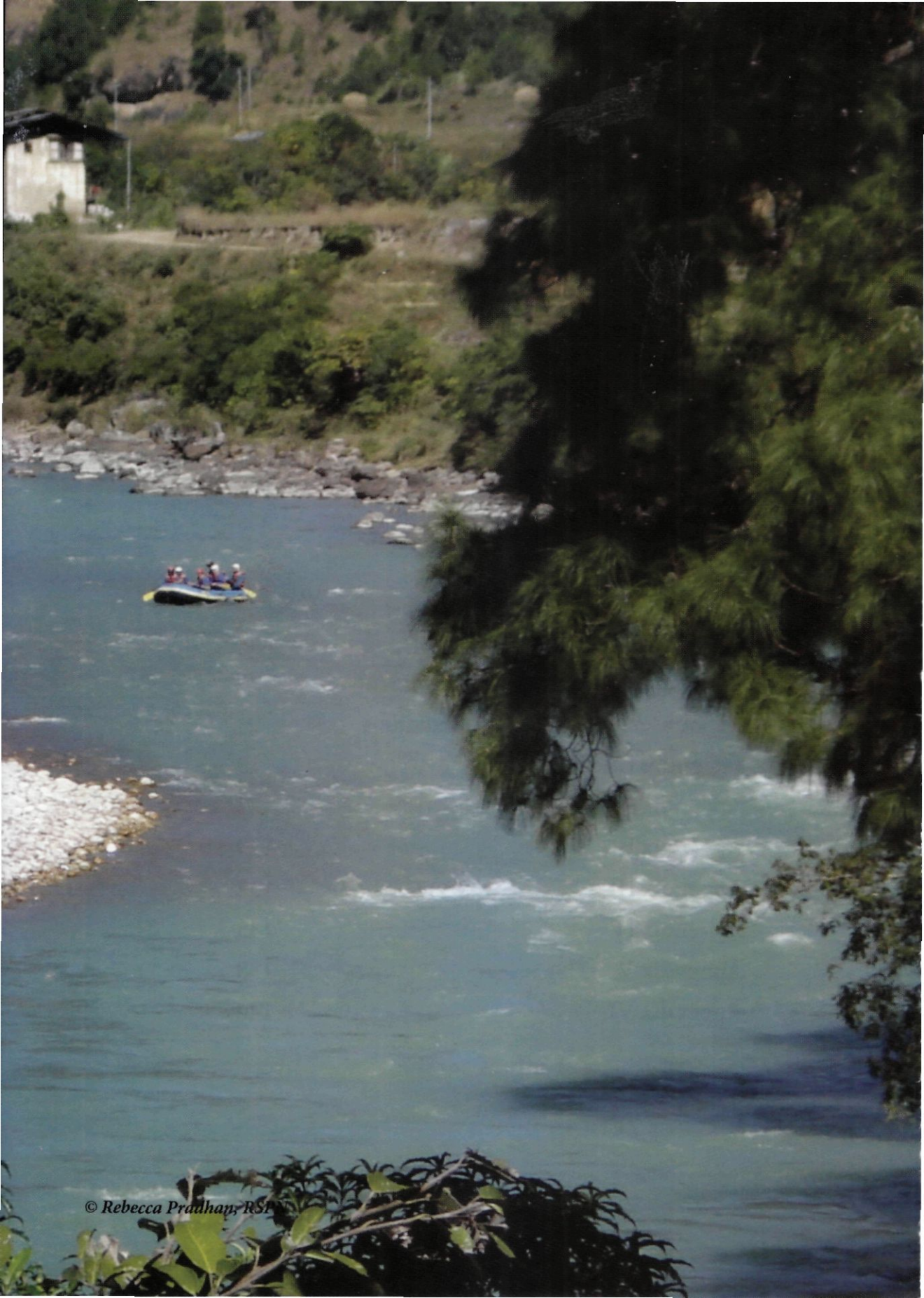
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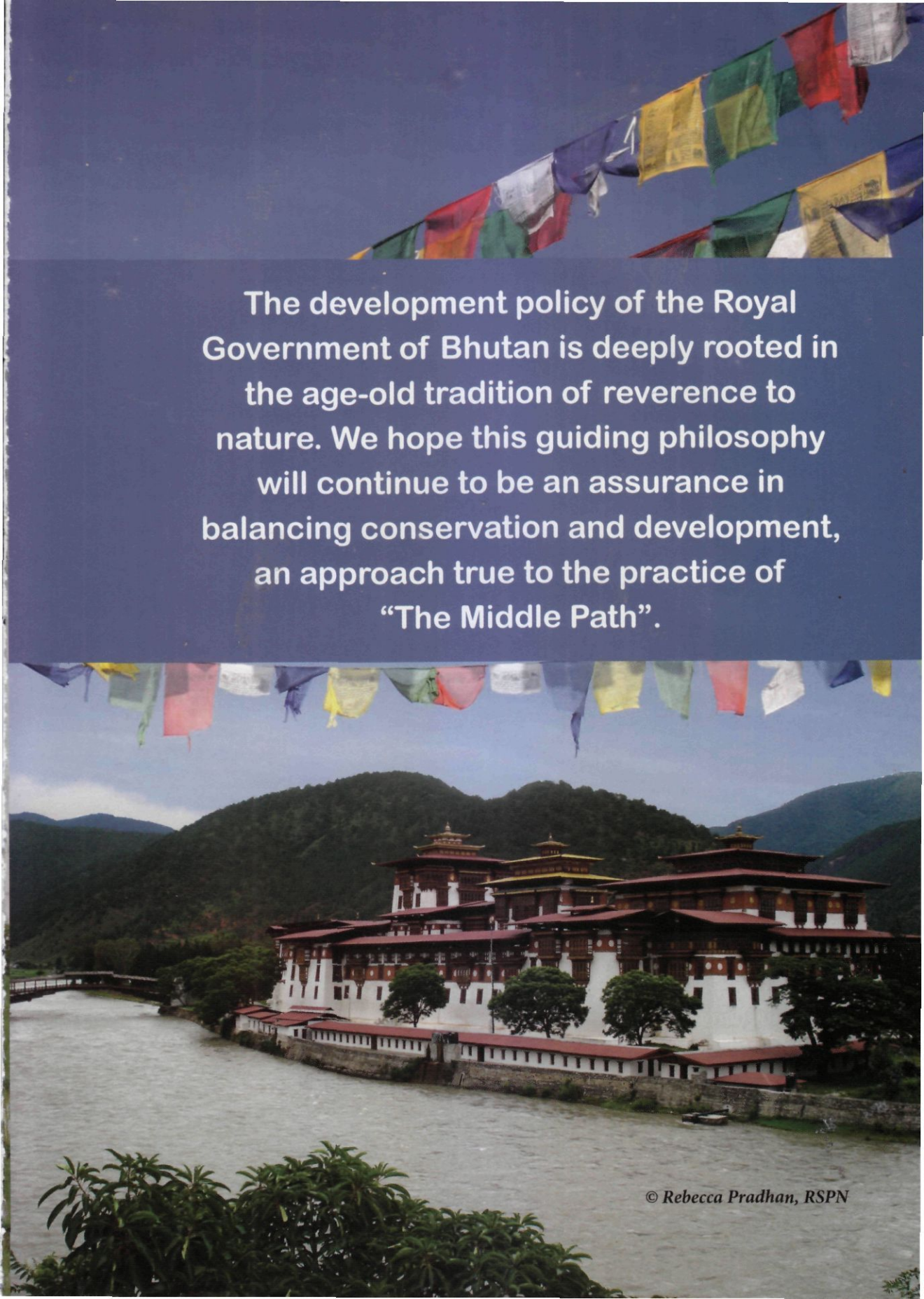
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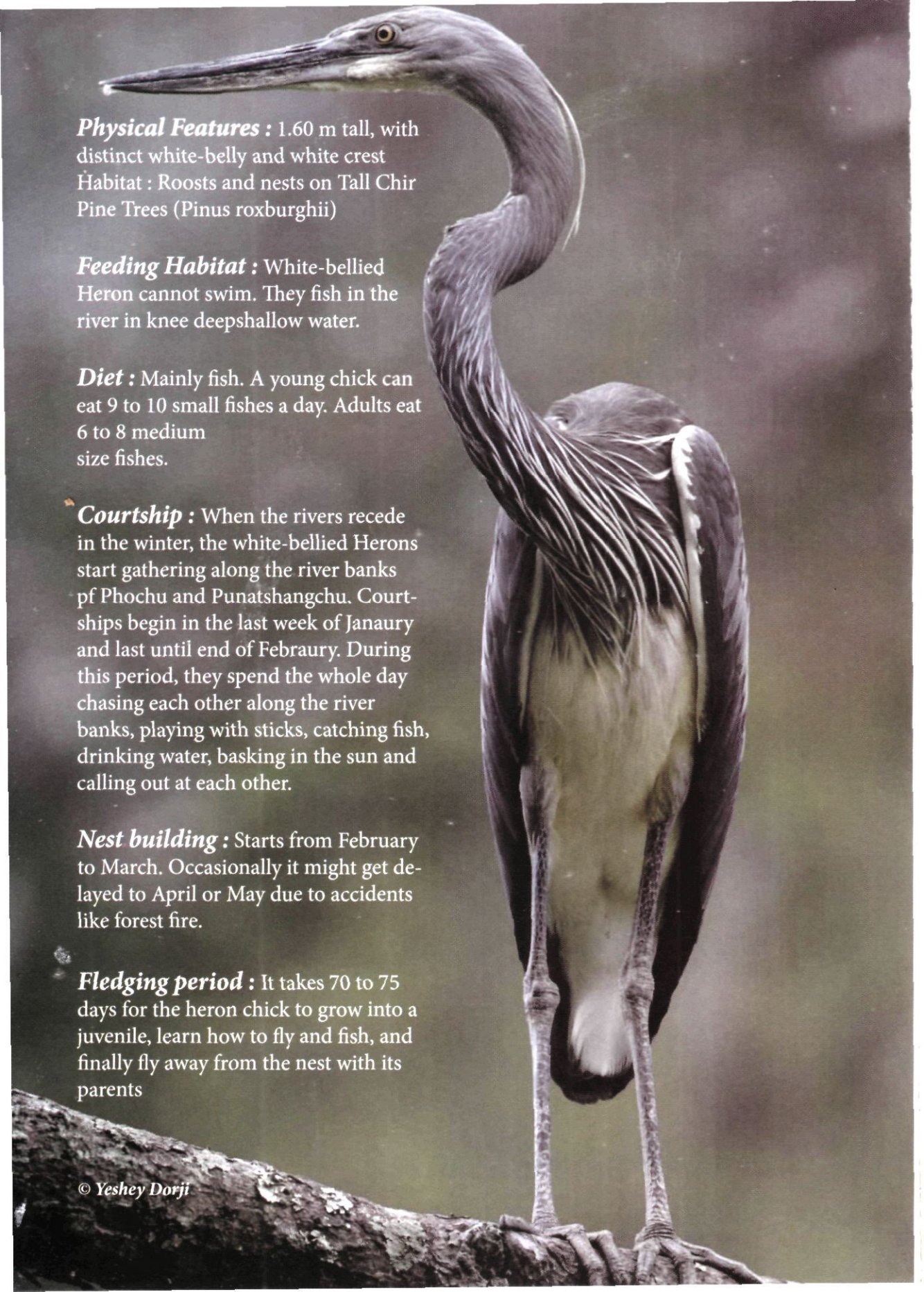






The development policy of the Royal Government of Bhutan is deeply rooted in the age-old tradition of reverence to nature. We hope this guiding philosophy will continue to be an assurance in balancing conservation and development, an approach true to the practice of “The Middle Path”.



A large white-bellied heron is perched on a thick, dark tree branch. The bird is facing left, with its long neck elegantly curved. Its plumage is a mix of dark grey and white, with prominent white streaks on its wings and back. The background is a soft, out-of-focus green, suggesting a natural habitat. The lighting is even, highlighting the texture of the bird's feathers and the bark of the branch.

**Physical Features :** 1.60 m tall, with distinct white-belly and white crest  
**Habitat :** Roosts and nests on Tall Chir Pine Trees (*Pinus roxburghii*)

**Feeding Habitat :** White-bellied Heron cannot swim. They fish in the river in knee deep shallow water.

**Diet :** Mainly fish. A young chick can eat 9 to 10 small fishes a day. Adults eat 6 to 8 medium size fishes.

**Courtship :** When the rivers recede in the winter, the white-bellied Herons start gathering along the river banks of Phochu and Punatshangchu. Courtships begin in the last week of January and last until end of February. During this period, they spend the whole day chasing each other along the river banks, playing with sticks, catching fish, drinking water, basking in the sun and calling out at each other.

**Nest building :** Starts from February to March. Occasionally it might get delayed to April or May due to accidents like forest fire.

**Fledging period :** It takes 70 to 75 days for the heron chick to grow into a juvenile, learn how to fly and fish, and finally fly away from the nest with its parents



# Foreword

The Critically Endangered White-bellied Heron is a culmination of over eight years of dedicated field investigation and ecological study of the White-bellied Heron in Bhutan. The White-bellied Heron with a population of about 200 known individuals in the world, of which 26 individuals have been recorded in Bhutan, is globally endangered bird species. Very little is known about the White-bellied Heron, and information on their biology, ecology and conservation needs is even more scarce. The Royal Society for Protection of Nature and its team of researchers have done a commendable job by investing their time, energy, expertise and more importantly undying passion and dedication in initiating the first ever scientific study of the White-bellied Heron. This book presents a detailed account of the bird including its distribution, habitat preferences, foraging ecology, nesting ecology, major threats and conservation needs in Bhutan.

In the midst of rapidly changing world, Bhutan is no alien to modern development. As a developing country, diversification of economic activities and infrastructure enhancements are important components of modern development. At the same time Bhutan's forests and wildlife has always been our much revered and upheld natural heritage. Together with our culture and tradition, Bhutan's uniqueness in the era of globalization is our well-conserved nature. The existence of 26 White-bellied Herons in Bhutan is no coincidence. It is a testimony to our long sustaining conservation efforts. As we tread the path of modern development, conservation challenges are bound to increase. Much will be lost and more will be threatened, but it is essential to keep the spirit of conservation alive. I hope the Royal Society for Protection of Nature will continue with such wonderful work and strive to achieve greater heights in the years ahead.

I am sure this book will not only draw the attention of scientists and conservationists within Bhutan and abroad, but also reach out to policy and decision makers whose interest and support is crucial to the survival of this species. Only through the wise decisions of policy makers crafted from the authentic findings of biologists and conservationists will the globally endangered White-bellied Heron live through generations to see another century.



Dasho Paljor J. Dorji

*Dasho Paljor J. Dorji is the founder of the Royal Society for Protection of Nature. He established RSPN in 1985*



# Tribute

## The Remarkable and Much-loved Ellie Schiller

ELLIE SCHILLER (1944-2009) was a hard-working, no-nonsense, straight-to-the-point woman with a heart of gold, loved nature, and enjoyed the sunshine but shunned the limelight. She became fascinated by the Himalayas, Tibetans and Buddhism when, following graduation from university, she spent half a year living with Tibetan refugees in Darjeeling where she taught the children mathematics.

When Ellie visited Bhutan with me in 2002, our excellent tour guide, Hishey Tshering, showed us a White-bellied Heron along the Mo Chuu (river) in Jigme Dorji National Park. Deep within the cathedral-like forest, the majestic heron stood motionless out in the water a few meters from a wide deposit of exposed gravel. Suddenly it thrust its long grey neck and enormous dagger-like beak into the water and caught a hefty fish almost as long as the heron's neck. By pressing her tiny camera to Hishey's telescope, Ellie took pictures of the drama. As a professional fisheries biologist, she was especially interested.

“ It's been said that future generations will remember us for what we save. Ellie and the Felburn Foundation will always be remembered by what they did to help the White-bellied Heron during its time of peril. ”

Ellie's father, J. Phil Felburn had established the Felburn Foundation with the simple mission of preserving nature. After he passed away in 1998, Ellie assumed primary responsibility for the foundation and supported many conservation initiatives.

One of Ellie's favorite sayings was, “You can't put it back when it's gone.” Consequently, the Felburn Foundation in partnership with WWF-Bhutan, through the International Crane Foundation and the Royal Society for the Protection of Nature, became a primary supporter of efforts to study and conserve one of the rarest and most endangered of birds worldwide, the White-bellied Heron.



It's been said that future generations will remember us for what we save. Ellie and the Felburn Foundation will always be remembered by what they did to help the White-bellied Heron during its time of peril. Let us hope that through these treasured birds, Ellie's remarkable spirit will always be in the Himalayas. Ellie will be especially missed for her good humor, unbridled joy at things she loved, and her unflinching championship of nature, children and education. She inspires us to continue her legacy.

Dr. George Archibald  
Co-founder  
International Crane Foundation



© George Archibald, ICF



# Acknowledgements

This study would not have been possible without the help and encouragement of many people. We thank George Archibald for his expertise, encouragement, and experience that has brought many of the necessary people together and kept the project going. We thank The Fellburn Foundation for continued financial assistance, World Wildlife Fund Bhutan Office, Critical Ecosystem Partnership Fund and Whitley Fund for Nature for additional financial support, were instrumental to the success of the study.

We would like to acknowledge the support and encouragement of Dasho Paljor J. Dorji (Benji), Advisor to National Environment Commission, for his vision, enthusiasm and guidance. Dasho Nado Rinchen, Former Deputy Minister of National Environment Commission and Mr. Sudir Viyas, former Indian Ambassador to Bhutan, for their wholehearted support. We wish to extend our gratitude to Dr. Ugyen Tshewang, Secretary, Mr. Tshering Tashi, Environment Specialist & Thinley Namgay of National Environment Commission, Dasho Dawa Tshering, former Director General of Department of Forests, Mr. Karma Drukpa, Director of Department of Forest and Park Services, Dr. Sangay Wangchuk, Nature Conservation Specialist, Mr. Phento Tshering, Chief Forest Officer, Wangdue Division and his staff, Mr. Nawang Tenzin, Ada Park warden & his staff, Mr. Lobzang Dorji, former Chief Forest Officer, Thimphu Division, Mr. Sherub, Ugyen Wangchuck Institute of Conservation and Environment and Karma Tenzin, Livestock Officer, Department of Livestock for their support.

Mr. Hishey Tshering, Proprietor of Bhutan Birding and Heritage Travels, has helped us in finding initial funding for the project. He has always been a keen supporter and was involved in the project from the very beginning. His passion for conservation activities and resourcefulness is greatly acknowledged. Mr. Mincha Wangdi of WWF Bhutan has provided selfless support during the initial period of project implementation and has provided his personal filming equipment free of cost. Mr. Yeshey Dorji, Professional Bird Photographer, has helped us publicize the case of the White-bellied Heron through his stunning photographs. Jason Edward of National Geographic provided some astonishing photographs of the White-bellied Heron.

In the field, we would like to thank Dzom Gup, Tewang Gup, and the communities of Punakha Dzongkhag for their support; the communities of Zawa, Nangzhina, Ada, Hararongchu, Kamichu and road workers along

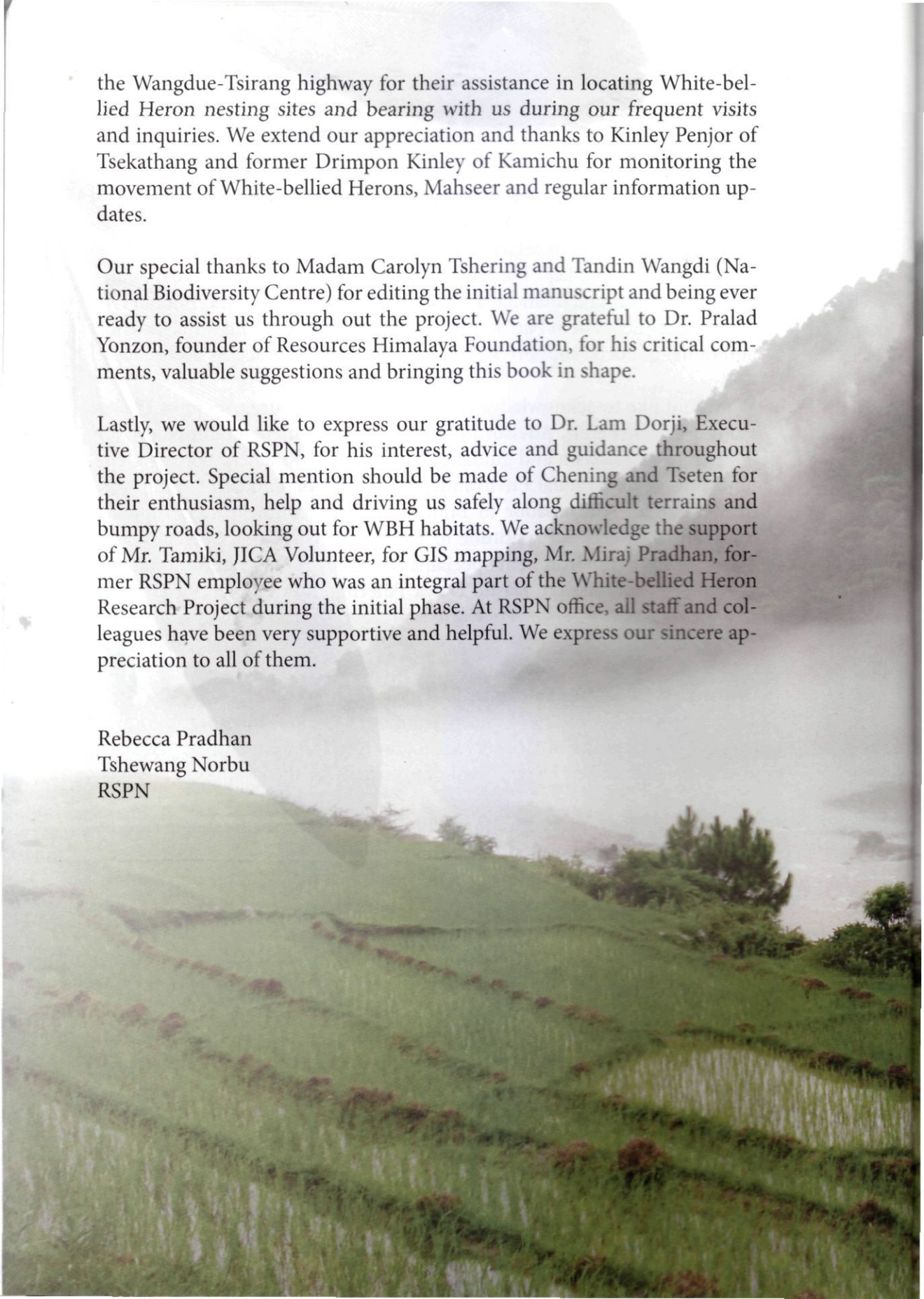


the Wangdue-Tsirang highway for their assistance in locating White-bellied Heron nesting sites and bearing with us during our frequent visits and inquiries. We extend our appreciation and thanks to Kinley Penjor of Tsekathang and former Drimpon Kinley of Kamichu for monitoring the movement of White-bellied Herons, Mahseer and regular information updates.

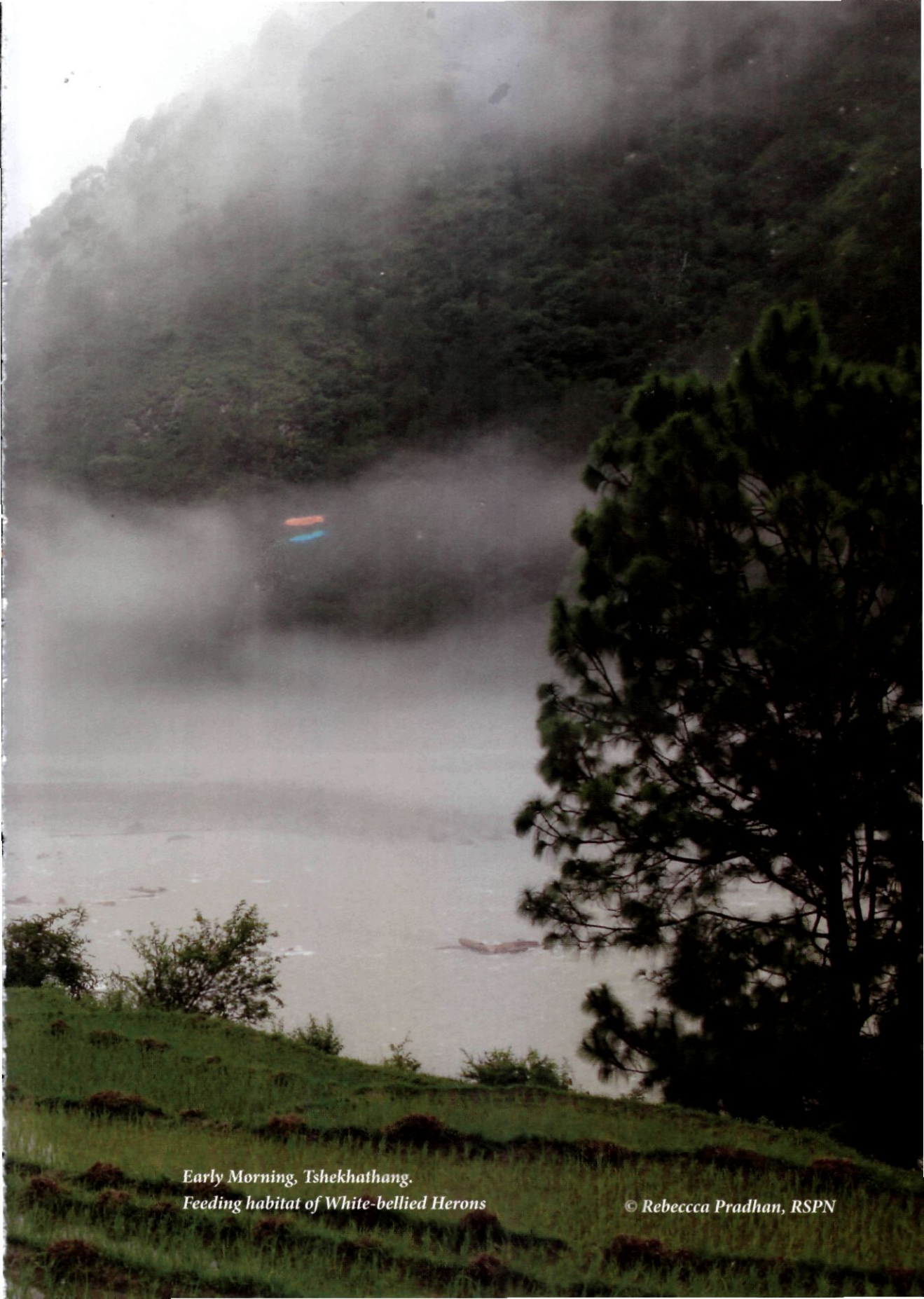
Our special thanks to Madam Carolyn Tshering and Tandin Wangdi (National Biodiversity Centre) for editing the initial manuscript and being ever ready to assist us through out the project. We are grateful to Dr. Pralad Yonzon, founder of Resources Himalaya Foundation, for his critical comments, valuable suggestions and bringing this book in shape.

Lastly, we would like to express our gratitude to Dr. Lam Dorji, Executive Director of RSPN, for his interest, advice and guidance throughout the project. Special mention should be made of Chening and Tseten for their enthusiasm, help and driving us safely along difficult terrains and bumpy roads, looking out for WBH habitats. We acknowledge the support of Mr. Tamiki, JICA Volunteer, for GIS mapping, Mr. Miraj Pradhan, former RSPN employee who was an integral part of the White-bellied Heron Research Project during the initial phase. At RSPN office, all staff and colleagues have been very supportive and helpful. We express our sincere appreciation to all of them.

Rebecca Pradhan  
Tshewang Norbu  
RSPN







*Early Morning, Tshekhang.  
Feeding habitat of White-bellied Herons*

© Rebecca Pradhan, RSPN





© Yeshey Dorji, Photographer

Nesting time, Basochha, Wangdiphodrang



# I. Background and General Information

The White-bellied Heron (*Ardea insignis* Hume) is the world's second-largest heron, known historically from the eastern Himalayan foothills of India, Nepal, Tibet, Bhutan, and Burma (Ali and Ripley 1978, Grimmett et al. 1999, Smythies 1953, Birdlife International 2001). Aside from plumage descriptions, status, and distribution, the species has never been studied directly to any great extent, and surprisingly little is known about its biology, morphometrics and ecology (Hancock and Kushlan 1984).

Historical records, recent sightings, and virtually all available information about the biology of the species have been aptly summarized elsewhere (Birdlife International 2001, updates in IUCN 2008), and we refer readers to those documents for an authoritative treatment of existing literature. Usually seen as single birds, pairs and occasionally groups of 4 - 5, the species has never been described as abundant anywhere. It does seem clear, however, that the range of the White-bellied Heron has contracted markedly during the past century. By the early 1990s, the species was no longer seen in much of its former range, and is thought to be extirpated from Nepal, Tibet and much of northern India. Most of the sightings since 1990 were from Arunachal Pradesh (Maheswaran 2007) and Assam in India, northern Burma, and Bhutan, with many formerly productive locations even in those areas, now without birds. Because of the likelihood of very low population size (200 - 500 birds worldwide, Hancock and Kushlan 1984, Birdlife International 2001), rapid range contraction, and the extreme vulnerability of riverine habitat to human exploitation in the region, the species is now listed as critically endangered worldwide (IUCN 2008).

The species has been widely listed as occurring in Bhutan (Ali and Ripley 1978, Grimmett et al. 1999) with many published sightings during the early 1990s. The first verified sighting known to us was reported by His Majesty the Fourth King of Bhutan in 1976, who encountered a White-bellied Heron while fishing in the Mo Chu and positively identified the species. In 1991, Carol and Tim Inskipp spotted a lone White-bellied Heron at Ada lake. In 1993, Rebecca Pradhan and Tandin Wangdi saw two adults and one juvenile at Ada lake. Since then, there has been regular sightings of the White-bellied Heron in the Mo Chu, Pho Chu and Punatsang Chu drainages. It remains unclear whether the White-bellied Heron has become a regular resident only recently, or whether it has always been a typical member of the avifauna that was rarely noted.

It seems unlikely that this species will regain much of its former range simply because most of the habitat is now densely populated with humans and



has become highly altered. Conservation of White-bellied Heron therefore seems to depend on preserving and perhaps enhancing the features of its remaining habitat that are critical to its existence. Yet many basic aspects of the ecology of this species remain poorly known or are completely unknown, and existing information on some points is sometimes even contradictory. Thought to eat mostly large fish (*Hancock and Kushlan 1984*), the only quantitative report of food habits is from a single stomach that contained only crayfishes (*Baker 1922 - 1930 in Birdlife International 2001*). Considered resident by some accounts (*Ali and Ripley 1978*), evidence of post breeding movement or migration into lower altitudes and flatter terrain in colder months has been presented (*Birdlife International 2001*). The literature suggests a strong association of this species with riverine broadleaf forests, and it is unclear whether sightings outside of this habitat are birds temporarily in suboptimal habitat, or if grasslands, lakes and wetlands of flat country can also support the species. So little is recorded about food habits or foraging ecology that it is very difficult to understand the ecological processes or prey animals that WBH are dependent upon, either for foraging or breeding. There is also very little known about reproduction of this sparsely distributed and secretive species. The only published information includes rough descriptions of 2 nests, both large structures placed in particularly tall trees in India and Burma (*Hume and Oates 1889-1890, Baker 1922-1930, in Birdlife International 2001*). In one case, four eggs were found in a nest in Burma. While sightings of adults and juveniles together are suggestive of family groups, there is almost nothing known of the social structure or degree of territoriality of this species, or the length of dependency of young on parent. Finally, and perhaps most importantly, little is known of the size or genetic structure of the population, or movement within the range. The very small population size and possibility of sedentary, isolated breeding groups means that genetic isolation could be one of the greatest threats to the existence of this species.

Here, we report on the results of recent studies in Bhutan of distribution, foraging ecology, reproduction, habitat preferences, movements, behavior and reproduction.









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Feeding and Nesting habitat  
Hararongchhu, Wangdiphodrang



A scenic view of a river flowing through a lush, green mountainous landscape in Bhutan. The river is in the foreground, surrounded by dense vegetation and steep, forested hills. The sky is clear and blue.

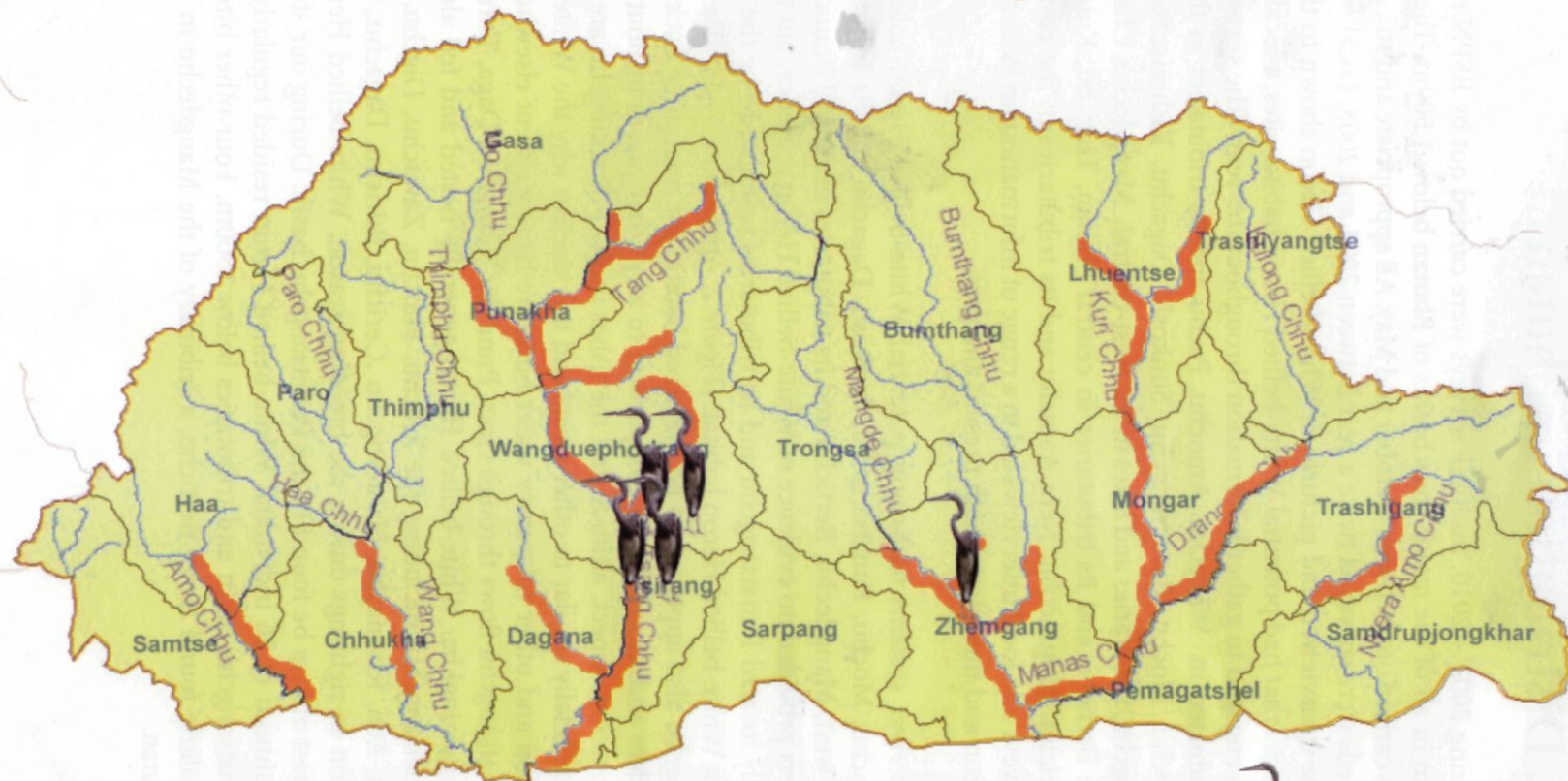
## II. Distribution in Bhutan

During 2003 – 2010, multiple surveys were carried out by RSPN research team in all of the major river basins of Bhutan below 1,500m. The survey was carried out between October and May. All appropriate and suitable riverbeds were surveyed twice a year between 2003 and 2008. Local residents were interviewed and pictures of White-bellied Heron shown to them. In villages that had potential White-bellied Heron habitat sites, a local person was engaged to gather information throughout the year. The surveys were conducted in Wangchu, Amochu, Pachu and its tributaries in the west, Phochu, Mochu, Punatsangchu, Sunkosh, Dagachu, Kishonachu, Hararongchu, tributaries and lakes in the west-central, Mangdechu, Chamcharchu Bertichu and its tributaries in central Bhutan, Tserichu, Kulongchu, Kurichu Dangmechu, Nera Aamchu and its tributaries in the east. These surveys and local interviews led to a range of information on White-bellied Heron and their nests, both present and past.

The river systems harboring potential White-bellied Heron habitats are Phochu, Mochu, Punatsangchu, Sunkosh, Dagachu and its tributaries in the west, Mangdechu, Bertichu and its tributaries in central Bhutan. Most rivers provided no evidence of White-bellied Heron presence, but the centrally located Punatsangchu and its tributaries emerged to be the permanent White-bellied Heron habitat. (*Figure 2, Appendices 2 –4*). The Punatsangchu also appeared to be preferred habitat for migratory ducks, other waders and shorebirds in comparison to any other places in Bhutan. The vegetation, aspect, altitude and the fishes in the Punatsangchu are at least superficially similar to other rivers and it is unclear why the White bellied Heron and other migratory water birds are largely absent elsewhere. The Punatsangchu flows through Gasa, Punakha, Wangdue, Daga, Tsirang and Lhamozingkha. White-bellied Heron generally nested and fed along the Punatsangchu, including the Mochu, Phochu, Zawachu, Digchu, Kamechu, Ada, Kisonachu, Hararongchu, Cerichu, Burichu, Dagachu.. In addition to sightings during the breeding season, White-bellied Heron can almost always be found in the Punatsangchu basin. During our studies, a minimum of 26 individual White-bellied Heron resided regularly in the Punatsangchu basin and tributaries below 1500m. Four other birds were regularly found along Bertichu, a tributary of the Mangdechu in Central Bhutan.



# White-bellied Heron Surveyed Areas



Scale : 1,000,000

0 30,000 60,000 120,000 Meters



Nesting sites



Surveyed area



## Heron Nesting and Feeding Sites in Punakha and Wangdue Phodrang









### III. Population Size

We used two techniques for documenting the population size of White-bellied Heron: nest surveys and synoptic winter counts. These represent breeding and wintering populations respectively, though it seems very likely that the adults in both counts are largely the same individuals.

#### *Nest survey*

The first White-bellied Heron nest in Bhutan was discovered in April 2003 in Zawa by Ap Kinley, a local resident of Zawa village under Wandue Phodrang Dzongkhag. During the first two ensuing years, one nest in the vicinity of Zawa was studied intensively (*Appendix II*). In February 2005, during the regular monitoring of the White-bellied Heron in Zawa RSPN research team found a new nest about half a kilometer upstream, north of the old nest. The old nest had been abandoned after two years. Intensive preliminary field survey was carried out along rivers and Chir Pine forests (*Pinus roxburghii*) looking for White-bellied Heron and their roosting and nesting habitat. Every opportunity was taken to interview local residents aided with pictures of White-bellied Heron and audio record of White-bellied Heron call. The second survey was carried out only in those areas where signs of White-bellied Heron presence were found.

During one of the preliminary surveys we saw a big bird flying along the Hararongchu from a distance but was not sure whether it was a heron. We followed the bird and found evidence of an old nest on a Chir Pine tree. We conducted a second survey along Hararongchu and found a new nest. Whenever a nest was discovered, we looked for evidence of breeding around the site by checking the nearby trees within the same drainage and watching for adult birds flying along the stream valleys. Our searching effort was variable over the years. However, in each year, we visited all previously known nests during the nesting season, and attempted to find other nest sites in the vicinity, for instance within 10 km in the same drainage. Using this technique, the number of potential nest sites to be surveyed in any year grew from 1 active nest in 2003 to 5 in 2010.

We documented between 1 and 5 nests in any year, nearly all were located along the Punasangchu tributaries, with one nest in Bertichu (*Table 1, Appendix 5*). Between 2003 and 2006, it seems likely that we were missing many of the nests that we later found to be active, simply because our nest searches had not expanded by that point to the appropriate drainages. However, the absence of nests at sites that had earlier been active represented true abandonment of nests, with new nests in other previously sur-









*six weeks old chicks with a parent ,Basochhu, Wangduphodrang*



veyed nearby locations (*Zawa II for example*) indicating movement to new sites. For this reason, the best way to assess the nesting population is the maximum numbers of nests in any year.

Together, this information suggested that there is a minimum regular breeding population of at least 5 pairs (*10 adults*) in entire Bhutan. Since there is considerable area of appropriate habitat that has not been searched intensively in Bhutan, we strongly feel that this is a minimum number, and the true population could be considerably larger. Nonetheless, even if the breeding population were twice as the counts suggest, there would still be only 20 adults involved. This is an extremely small number of individuals from the point of view of genetics and population viability.

### *Synoptic winter population counts*

We performed simultaneous surveys of White-bellied Heron in all known locations where they could be regularly found during the late winter. During this time, the birds are generally associated with a particular river reach or stream, and do not appear to be making large movements.

As with nest surveys, the number of drainages and area searched, increased markedly over the years of study, so have new nesting sites and winter home ranges. For this reason, the distinct upward trend in numbers of individuals from 2003 – 2008, and the plateau in 2008 and 2009 should not be seen as a population increase, but an increase or plateau in survey effort.

The results of these surveys indicate that there is currently a minimum of approximately 30 individual birds during winter in the Punasangchu and Bertichu drainages in central Bhutan (*Tables 1, 2*). If it can be assumed that these birds are non-migratory at least at the scale of the area encompassed during the winter survey, this would suggest approximately 10 regularly breeding adults (as above) and 20 others that are juvenile or non-breeding adults.



**Table 1 : Population counts White-bellied Herons during nesting and non-nesting seasons from 2003 - 2010**

Year	Number of nests *						Total Nests	White-bellied Herons Individuals												Total Birds
	Za	Ad	Na	Ha	Be	Ba		Ha	Na	Ad	Za	Ka	Bu	Mo	Po	Pu	Be	Sg	Ge	
2003	1						1	0	0	3	2	2	0	0	2	4	0	0	0	14
2004	1						1	0	0	4	4	2	0	3	3	2	0	0	0	18
2005	1						1	0	0	3	4	2	0	1	3	2	0	0	0	15
2006	1		1	1	1		4	5	2	2	4	2	1	1	2	2	3	0	0	24
2007			2	1	1	1	5	3	2	2	2	2	2	1	5	2	4	0	0	25
2008		1	1		1		3	4	4	4	2	4	2	2	3	3	4	0	0	30
2009		1	2	1	1		5	4	7	7	1	3	1	1	2	3	5	0	0	30
2010			3				3	4	6	2	2	2	0	0	2	1	4	2	1	26

\*Za = Zawa or , \*Ad = Ada Lake, \*Na = Nangzina, \*Ha = Hararongchu, \*Be = Bertichu, \*Ba = Basochu. Ha = Hararongchu, Ka = Kisonachu, Bu = Burichu Mo = Mochu, Po = Phochu, Pu = Punakha confluence ,Sg=Sunkosh gaon, Ge= Gewachu, Za = Zawa or , Ad = Ada Lake, Na = Nangzina, Be = Bertichu, Ba = Basochu.



Winter Feeding Habitat Name of the Place	Altitude	Population status December 2010
Tshekathang/ Phochu	900m	2
Punatsangchu	1208m	2
Phochu/ Mochu confluence	1238m	1
Kamichu Jalarongchu	420m	2
Zawa	930m	2
Ada	1175m	2
Kisonachu	836m	6
Hararongchu	578m	4
Cherichu	390m	0
Sunkosh river oppo- site Salamji village	386m	1
Berti Chu/ Mangdechu	645m	4
Mangdechu	570m	0
Total		26

*Table 2. Locations and numbers of individual White Bellied Heron surveyed during December 2010 at Punatsangchu Basin*









*Nesting and feeding habitat at Ada lake, Wangduephodrang*











## IV. Foraging Ecology and Energetics

White-bellied Herons are known to forage in a wide variety of situations in fresh water bodies, including rivers and streams of both fast-moving and slow moving water, wetlands and lakes. In Bhutan, we have recorded birds foraging on two major rivers (*Punatsangchu* and *Bertichu*) and their tributaries, varying from approximately 15 – 300m in width. We have also recorded White-bellied Heron foraging at a small lake (*Ada*) of approximately 200m diameter with still water and extremely low water clarity. Because of visibility and reliable presence of the birds, our studies of foraging behavior and energetics have focused on a single site during winter (*Phochu*). Thus they are capable of foraging in a variety of other kinds of habitat (see also under *Reproduction*).

### *Winter Foraging Behavior*

We intensively studied foraging behavior at Phochu during October and March ( *Figure 1.*) During 2006-2009, there were 6-7 individual herons based on simultaneous appearance and plumage characteristics. Our observations were made over approximately 7.07 km of the Phochu, starting from confluence of the Mo Chu and Pho Chu near Punakha Dzong.

#### *a) Foraging observations*

Our observations included both short and long episodes of foraging, and were initiated by observers whenever a bird was spotted in typical hunting behavior. Observations were terminated by the focal heron flying off or stopping foraging behavior, by behavior altered by human disturbance, or may have been terminated by the observer for other reasons. During foraging observations, a single heron was watched through binoculars or telescope from a vantage point above the river at horizontal distances of 700 to 900 metres. We recorded numbers of steps, strikes, captures, and estimated distances of any flights based on landmarks later measured or distances on the road parallel to the river. Sizes of fishes captured were estimated by bill length in quarter-bill length increments (*Recher and Recher 1969, Mock and Mock 1980*). Species of fish captured was not recorded except in a few instances where the fish was quite large and easily recognizable.

#### *b) Foraging location characteristics*

During any foraging observation, herons might change locations, sometimes by over 500m, by walking or flying. We recorded characteristics of



the foraging site both at the beginning of an observation, whenever a heron made a significant change in foraging habitat categories, or moved by over 100m. Foraging sites were categorized by proximity to closest bank edge, order of channel size within the width of the often braided river (*usually 1 – 4 channels*), water surface characteristics (*smooth, riffles, rapids*), water depth as measured on the bird's leg and body (*ankle, tarsometatarsal joint, thigh and belly*) and proximity to roads, houses, foraging livestock and other sources of disturbance. Distances were measured to the nearest meter with a laser rangefinder (*Nikon ProStaff 440 8X20*). Flight distances on the river were measured after the fact using the rangefinder, or were estimated using measurements of km between landmarks as measured with an automobile odometer on the adjoining roadway.

### *c) Energetics*

We estimated energetic expenditures of herons in two ways. First, we estimated Field Metabolic Rate (*FMR*) for herons based on allometric scaling of *FMR* for body mass of birds (*Nagy 1987, 2005*) and then estimated caloric needs based on a 24-hr day. We are aware of no published body masses of White-bellied Heron, and so we estimated mass of White-bellied Heron using a relationship between published body masses and heights of other herons, ranging from small herons in the genus *Egretta* to large herons such as the Great-billed Heron (*Ardea sumatraensis*), and Goliath Heron (*Ardea goliath*). These results indicated a logarithmic increase in height as mass increased, and based on this relationship we estimated that a White-bellied heron of 127 cm height would weigh approximately 3,400 g. We also estimated energetic needs from behaviors, based on activity-specific energetic costs as derived from other avian studies (*Bzorad et al. 2004*). We multiplied those activity-specific costs by time, distance, number or other appropriate measures of those activities and behaviors.

### *d) Energy intake*

We estimated energetic intake using a combination of 1) caloric values of fish estimated from other studies, 2) estimated fish sizes, and 3) capture rates. Energy of fishes eaten was estimated by converting total estimated length of fishes (*as above, by increments of heron bill lengths*) to mass using length-specific relationships for Brown Trout (*Salmo trutta*) given in Schnieder et al. (2000).

$$\text{mass (g)} = 3.01 (\log_{10} \text{length}) - 5.03$$

While this was probably not completely accurate for the other fish species



likely to have been captured by herons at this location, eg. Snow trout( *Schizothorax richardsonii*), the two types of fish are not very different in body shape and proportions.

Based on previous work, we assigned a value of 7.87 joules/gram of wet fish mass (Kushlan *et al.* 1986, Frederick and Powell 1994), and assumed that herons eating a largely fish diet would have an assimilation efficiency of 79% (Frederick and Powell 1994).

### e) Energy expenditure

We assumed that birds sitting still (roosting, loafing, sleeping) expended close to their calculated Basal Metabolic Rate. We used BMR/mass relationships that were based on measurements from four heron/egret species (McNab 2008, equation 6) of

$$\text{Kj/hour} = 0.085(\text{mass(g)}^{0.705})$$

For the 3.2 kg White-bellied Heron, this translates in to 0.419 kj/minute. The main activity expenditure during hunting was stepping, which we estimated from previous studies of locomotor energetics. Heglund *et al.* (1982) modeled stepping as being mass- and speed- specific:

$$\text{Mass-specific stepping energy} = 0.478v_g^{1.53} + 0.685v_g + 0.072$$

where  $v_g$  is the speed of movement in m/s. We estimated speed of movement (0.331 m/sec) by timing a specific number of steps taken by a foraging bird moving along on a sandy beach, and then measuring the distance between first and last tracks on the beach to derive distance (mean step length = 37.33cm, +- 2.285cm SD, n=6 steps). Using this information we calculated mass specific stepping energy to be 0.387 joules/gram. This led to an estimate of 1.15 joules/step for the White-bellied Heron. Numbers of steps taken were multiplied by this figure to derive total energy expended by stepping.

We estimated the energy used in flapping flight from Pennycuick's (1975) methods, where the cost of flight in kilojoules/meter is:

$$\text{Energy} = \frac{(\text{Mass} * \text{acceleration of gravity})}{(L/D)}$$

Where L /D is the lift to drag ratio as calculated using constants and graphs









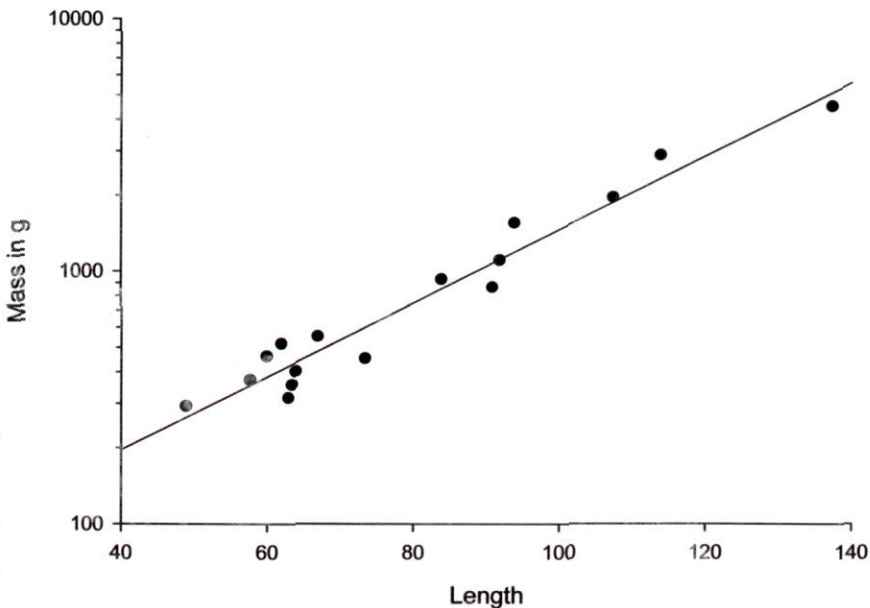


in Pennycuick 1975. We used an estimated mass of 3.4 kg (see below) and an estimated wingspan of 2.01 m based on allometric relationships of other heron species.

Total energy used was calculated by multiplying activity-specific energetic costs (above) by either the time (sitting), number of activities (steps) or distance (flapping flight). The activity-specific costs were then summed over all activities to derive costs of an individual or group of birds. We estimated total energetic costs during daylight hours using the average per-hour expenditure we estimated during foraging observations. For roosting hours at night, we assumed birds were expending close to BMR.

## *Foraging behavior and capture success*

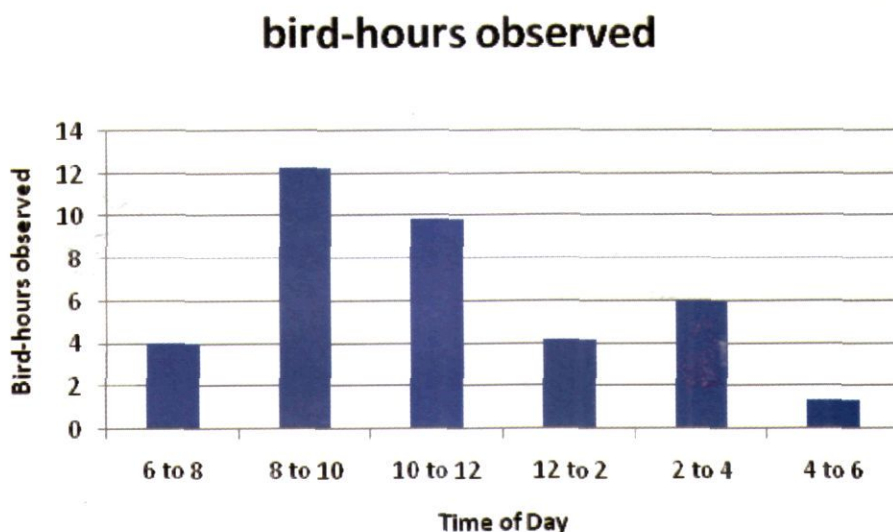
No record on body weight (masses) are available in the literature for the White-bellied Heron. We derived an exponential relationship between heron body mass and length, based on published measurements for 16 species worldwide (Figure 2). Based on this relationship, a White-bellied Heron that is 127 cm in length (Grimmett *et al.* 1999) is predicted to weigh approximately 3,418 g. For the purposes of calculating energetics we used 3,400 g as an average for White-bellied Heron mass.



*Figure 2. Relationship between total length (cm) and mass (g) for 16 herons or egrets; mass = 74 (e0302\*length) where mass is in grams, length is in cm. White-bellied Herons are reported as 127 cm total length.*



Between 10 and 19 November 2007, we observed between 3 and 5 individual birds for a total of 4,385 minutes, of which 3,123 minutes were actively foraging (72.5%), 1,011 roosting (23.1%), 81 bathing (1.6%) and 68 preening (1.5%). The remainder of the time was spent temporarily out of sight or flying. Foraging observations varied between 10 and 422 minutes in length, with a median length of 62 minutes. This is somewhat more time devoted to hunting than the 58% of time spent hunting by the Goliath Heron (Mock and Mock 1980) and 30 – 50% reported for the Great Blue Heron (*Ardea herodias*, Brandman 1976), and may indicate that the White-bellied Herons were having a more difficult time getting food than these other two large heron species. Birds were observed predominantly in the morning hours (0800 – 1200) with a somewhat bimodal peak (Figure 3).



*Figure 3. Frequency distribution of observations of White-bellied Herons observed during November 2007 at the Pho Chu site, by hour of day.*

White-bellied Herons hunted visually during all of our observations, and prey were stalked by combinations of standing still, or walking very slowly ( $x = 4.03$  steps/min). These techniques and sole use of visual cues and hunting by sit-and-wait or slow stalking are typical of other large ardeids (Butler 1992, Voisin 1991, Hancock and Kushlan 1984, Mock and Mock 1980). The Goliath Heron is probably closest in size to the White-bellied Heron, and is similarly extreme in rare capture events, long periods of sitting still waiting for prey, and very slow stepping rates (3 – 4 /min). Stepping rates in White-bellied Heron were highly variable across observations (s.d. = 3.89 steps/min,  $n = 40$  observations), and most steps were observed when herons moved between foraging places rather than during active









Roosting site at Zawa, Wangduephodrang



hunting. Much of the time, herons were sitting still, peering into the water and/or poised to strike. Prey were captured with a rapid downward or oblique jab. Prey were nearly always grasped between the mandibles rather than stabbed through the body. This is quite different from Goliath Herons, which nearly always stab larger prey through the body (Mock and Mock 1980). Great Blue Herons captured prey by skewering approximately 16% of the time (Butler 1992). It may be that the entirely rocky substrate used by White-bellied Heron posed a risk for stabbing, in that the bill could be injured by pushing through the prey item and striking a hard surface. Captures by White-bellied Heron were infrequent, with only 11 captures seen in 4,385 minutes ( $x = .0057/\text{min}$ ,  $s.d. = 0.0156$ ,  $n = 40$  observation sessions). Striking efficiency was high, ( $x = 1.2$  strikes/capture,  $s.d. = 0.121$ ,  $n = 10$  observations). This rate of capture (0.342/hour) was quite similar to the hourly rate reported for Goliath Herons (0.332), though White-bellied heron captured considerably smaller prey.

All captures were fish, and no invertebrates or anurans were seen. Based on a reported midpoint of bill sizes of 152 mm (Ali and Ripley 1978), captured fish ranged in size from an estimated 7.7 to 30.8 cm in length (mean 16.2,  $s.d. 10.53$ ,  $n=7$ ). These are considerably smaller than fishes captured by Goliath Herons (mean 30 cm). Once captured, herons typically swallowed the fish quickly for small and medium sized fish (0.25 – 1.0X bill length). On many occasions we observed White-bellied Heron feeding on fishes bigger than their beak size. Larger fish (cf. 1.2X bill length and larger) were carried to rocks or sand bars, where they were often repeatedly stabbed. Herons often dipped subdued large prey in the water several times before swallowing them. After swallowing, birds usually drank water 1 – 10 times, often intermittently shaking the head and extending the neck horizontally. This behavior is typical of other ardeas handling small and large prey.

We sampled fishes available in the river (by permit) using a cast net with mesh size of approximately 2 cm (stretched dimension). Despite repeated sampling, we found only two species large enough to be captured using this technique, Brown Trout (*Salmo trutta*) and Snow Trout (*Schizothorax richardsonii*). We therefore assumed that these species were the two most commonly captured by the herons. We did identify both species as being taken in one or more foraging observations involving large captures, but we were able to make no quantitative estimates of the relative use of either species by the herons.



In 7 of the 42 observations, both adult and apparently juvenile herons repeatedly (up to 49 times in succession) struck the water, apparently not at prey. These “pseudo-strikes” appeared to be aimed either at sticks or leaves, or at nothing at all. They were distinguished by the shallowness of the strike (bill not fully penetrating the water), and the fact that strikes were repeated in the same location. Pseudo-strikes varied between being extremely powerful and fast, to being obviously slower than strikes at prey. The function of these pseudo-strikes is unknown, and explanations may vary from practice striking, to displacement behavior.

Twenty seven of the 42 foraging observations included flights of between 1 and 1,000 meters. These flights did not include estimated flight distances of birds arriving to or departing from the observation area and the function of these flights appeared to be to move between foraging sites during a foraging bout. Estimated flight distances ranged between 1 and 1,000 m ( $x = 298$  m,  $s.d. = 354$  m, median = 70 m). For observations that included flights, numbers of flights within an observation ranged between 1 and 14 ( $x = 3.56$  flights,  $n = 27$  observations). Some of these flights appeared to be due to disturbance by humans (see under Disturbance below) and some were apparently birds moving between foraging sites, or between foraging and roosting sites.

### *Energetics of foraging during winter*

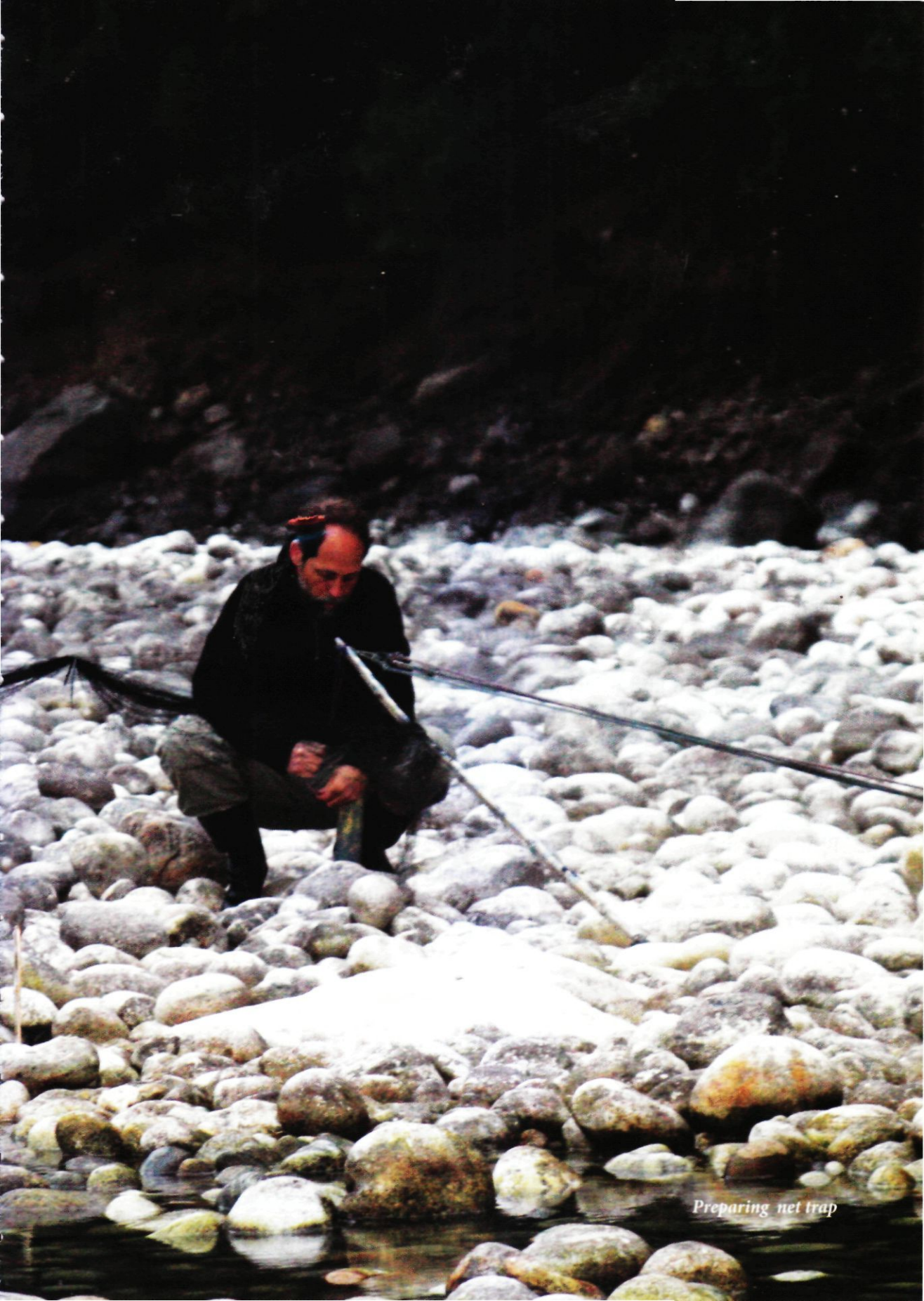
Based on allometric scaling of Field Metabolic Rate (*FMR*) of large-bodied birds (*Nagy et al. 1999*), we estimated that a 3.4 kg bird should expend between 2,600 kJ/d (scaling from measurements of all birds) and 3,027 kJ/d (procellariiform birds only).

We also used timed behaviors to estimate energy use. While foraging, herons expended relatively little energy in active behaviors (stepping, flapping flight), which totalled less than 2% of total estimated diurnal energy expenditure (Table 4). This is perhaps not surprising, since even when hunting they spent the vast majority of time sitting still, and energetically costly flights were rare. As above, the stepping rate was quite slow, and relatively little energy was expended per step. These results fit with the idea that these birds are energy minimizers, using very low-energy behaviors to achieve sit-and-wait foraging.









*Preparing net trap*



Activity	Ener- getic cost (kj)	Units	Units observed	Total activity Ex- penditure (kcal)	Percent of total energy	Bird- hours Observ- ation	Energy per bird-hour
Sitting	0.437	minutes	1,989	870.15	93.07	34.87	24.954
Flying	0.004	meters	15,279	55.59	5.95	34.87	1.594
Stepping	0.001	steps	6,994	9.21	0.98	34.87	0.264
Total				935.0	100	34.87	26.81

**Table 4. Estimated energetic expenditures of foraging White-bellied Herons during daylight hours on the Pho Chu and Mo Chu, west-central Bhutan, during winter in 2008.**

Total daily energy expenditure for these birds should include energy during time roosting at night, and flying to and from the roost. If daylight during winter lasts 9.5 h, then individual birds would expend a total of 254 kj during daylight. Assuming night-roosting birds are expending close to BMR and flying up to 3 km one way to the roost, we estimated they expended 362 kj during the approximately 14 h night. Total estimated daily energy expenditure for 24 hr would then total 616 kj.

The estimated 616 kj/d is less than 24% of the FMR estimated using allometric scaling (cf 2,600 kj, above). It would not be surprising that true FMR is considerably less than estimated FMR because the herons seemed to be extreme energy minimizers, moving very slowly if at all during the daytime, and flying only short distances between foraging sites or to roosts. During hunting, herons were probably expending only slightly above BMR. We may also have underestimated total energy expenditure using behaviors, since we did not include ambient temperature in our calculations. Since winter night-time temperatures were quite cold (-2 to 40 C for over 12 hours), this may have been an important oversight.

### *Daily Energy Budget*

We estimated that the birds captured and ate 17.5 g fish per hour of daylight foraging on average, or 166 g in a 9.5 hour day. This suggests White-bellied Heron may be eating in the neighborhood of 5% of body mass each day. This daily amount translates into approximately 138 kj /hour and with an assimilation efficiency of 0.79 they would have assimilated 109 kj/h or 1,035 kj/day, or 0.305 kj-gram body weight-1day-1. By comparison with the estimated daily energetic needs of 616 kj, the energy assimilated seems well in excess (1.7X needs), though of course this depends largely on body



size, temperature and other factors. It is important to also point out that herons appeared to catch enough fish to meet needs on average. But there were some days when individual birds must not have caught any fish, especially if we only observed 11 captures by 3 – 5 birds over a 12-day period. Therefore there are considerable periods of starvation for these birds in between the large captures. In addition, these calculations do not include any allowance for birds foraging at night, which we believe may be likely.

By comparison with the approximately 2,600 kJ estimated to be needed through allometric scaling, energy intake was only about 40% of energetic needs. We suspect that this 2,600 kJ figure is not appropriate for White-bellied Heron because of their very low energetic expenditure. If true energy expenditure were as high as 2,600 kJ/d, the birds we watched should have been quickly depleting body mass, and starving. We saw no evidence that birds were in poor body condition, or unable to perform typical behaviors. We can also compare daily food intake on a per-body weight basis with other herons. Based on reported energy intake by breeding (incubating) Great Blue Herons (Butler 1993), this species was eating approximately 7% of its body mass in food each day. Since breeding is likely to take up more energy than nonbreeding, this figure seems similar to the calculated 5% that we found with WBH. Mock and Mock (1980) estimated that Goliath Herons were consuming 23 – 34% of body mass/day, which seems quite high by comparison.

The White-bellied Heron seems to be an extreme energy minimizer during winter. This may be because energetic needs are low, or it may be because birds are forced to exert very little energy because food availability is low. During November, when we watched the majority of birds forage, the daily energetic needs of herons should be at their annual minimum, since the birds are neither reproductive nor forced to move long distances. The fact that birds kept foraging for long periods without prey captures suggests that they were limited by prey availability to a large degree. However, the evidence that they were able to exceed daily energy requirements by a large factor suggests that this limitation may not have been a primary driver of energetic expenditures.

It should also be noted that this species is capable of much faster food intake rates. For example, we observed a breeding adult foraging on the shores of Ada Lake, where fish are very abundant, partly due to high nutrient status as a result of frequent inputs of rice as religious offerings. On April 29, 2009, we recorded this individual capturing 9 fish in 3.75 hours, or 0.040 captures/min. This was 7 times as fast as the capture rate recorded for non-nesting birds during winter on the Pho Chu (0.0057 captures/min).

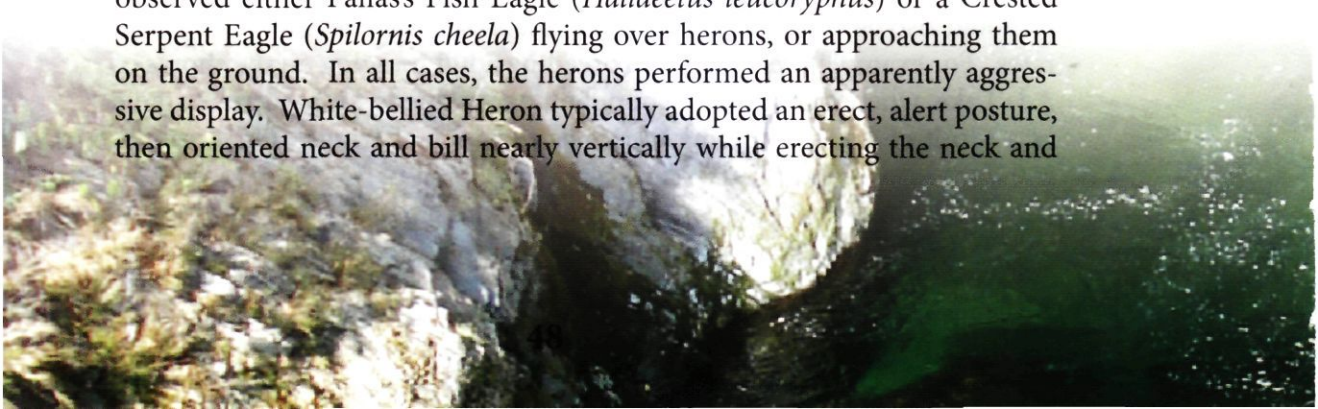


## Interactions with conspecifics and heterospecifics

We never saw agonistic interactions among herons, even those foraging as close as 25 m, suggesting that these birds are not territorial during the non-breeding season. However, with the small number of individuals observed simultaneously, it is also possible that all the birds were members of a single family (see Identification of age groups). We have observed apparently agonistic interactions at breeding sites involving displays, approaches and chases. It is therefore impossible to distinguish between the two interpretations that wintering birds on the Pho Chu were non-aggressive because they were closely related, or that wintering birds are simply not territorial. In an early effort to capture birds, we presented decoys of Great Blue Herons painted in White-bellied Heron plumage to the birds on the Pho Chu. There were no reactions to the decoys. It is possible that the White-bellied Heron did not perceive the decoys to be White-bellied Heron. However, in North America, presentations of heron decoys to Great Blue Herons have resulted in immediate aggressive behavior.

We observed two instances in a single day of herons foraging in close contact with Great Cormorants (*Phalacrocorax carbo*). The interactions took place in an isolated pool within a river bar. In one instance a cormorant landed in the pool where a heron was foraging. The White-bellied Heron began actively following the cormorant, probably attracted to fish scared up by the cormorant, and eventually the cormorant was driven out of the pool as a result of the heron following closely. The same morning in this same pool we observed two White-bellied herons being followed around the pool by one of two different individual cormorants (often within 2 m of the heron), and in one case aggressively chased by the cormorant after White-bellied Heron had captured a large fish. Later both White-bellied-Herons were apparently displaced from the pool after being repeatedly approached closely by a cormorant.

We saw no predation attempts on herons during our observations, but did note several interactions with raptors that suggested predation or food piracy by raptors might be a risk for herons. On 8 different days we observed either Pallas's Fish Eagle (*Haliaeetus leucoryphus*) or a Crested Serpent Eagle (*Spilornis cheela*) flying over herons, or approaching them on the ground. In all cases, the herons performed an apparently aggressive display. White-bellied Heron typically adopted an erect, alert posture, then oriented neck and bill nearly vertically while erecting the neck and





head feathers. This corresponds closely to the "vertical" display described for Great Blue Herons by Bayer (1984), and was used in the same context – raptors flying overhead or approaching. This was often followed by either holding the fluffed neck and head at 45 degrees to the horizontal and orienting the axis of the body towards the position of the eagle. This corresponds closely to the "Forward" aggressive display of Great Blue Herons (Bayer 1984), used in the context of aggressive display toward conspecifics. White-bellied Heron also pumped the neck and head up and down slowly with erected feathers, while maintaining the bill in a vertical position. While this pumping is not described as an aggressive display for Great Blue Herons at foraging sites, pumping is a typical nest defense display of ardeids. Vertical pumping was sometimes followed by a "bow" forward, arching the extended neck until the bill nearly touched the water; in several cases wings were opened partially or completely. This corresponded to the "Arched Neck" display of Great Blue Herons, used as a general purpose territorial display (Bayer 1984).

White-bellied Herons sometimes opened their bills during parts of these displays, and may have vocalized though the distance and noise of the river precluded confirmation. In one case a Pallas's Fish Eagle landed within 70 m of an adult and a juvenile plumaged heron. Both herons continuously displayed aggressively over the course of 15 min, and the adult heron approached to within 50 m of the eagle, possibly to place itself between the eagle and the juvenile. In another case a juvenile heron defended a preferred foraging spot (which we had baited with live fish) from a Crested Serpent Eagle. The juvenile displayed aggressively as above, and eventually displaced the eagle by flying towards it.

Crested Serpent Eagles and Pallas' Fish Eagles may have presented both predation risk and competition to White-bellied Herons, and our observations do not allow distinction between these sources of conflict. However, the interactions we observed are quite similar to those between Goliath Herons and Fish Eagles (*Haliaeetus vocifer*) in Africa, both in the degree of aggression directed at eagles, and the contexts in which eagles appeared near herons (baited pools, recent captures by herons). While we did not observe direct predation attempts on herons, it is unclear whether either eagle might consider this very large heron as prey. Cormorants, ibisbill (*Ibidorhyncha struthersii*), River Lapwings (*Vanellus duvaucelii*), Kestrels (*Falco tinnunculus*) and on one occasion, a small unidentified accipiter hawk, all elicited no reaction from herons even when approaching closely (20 m or less).





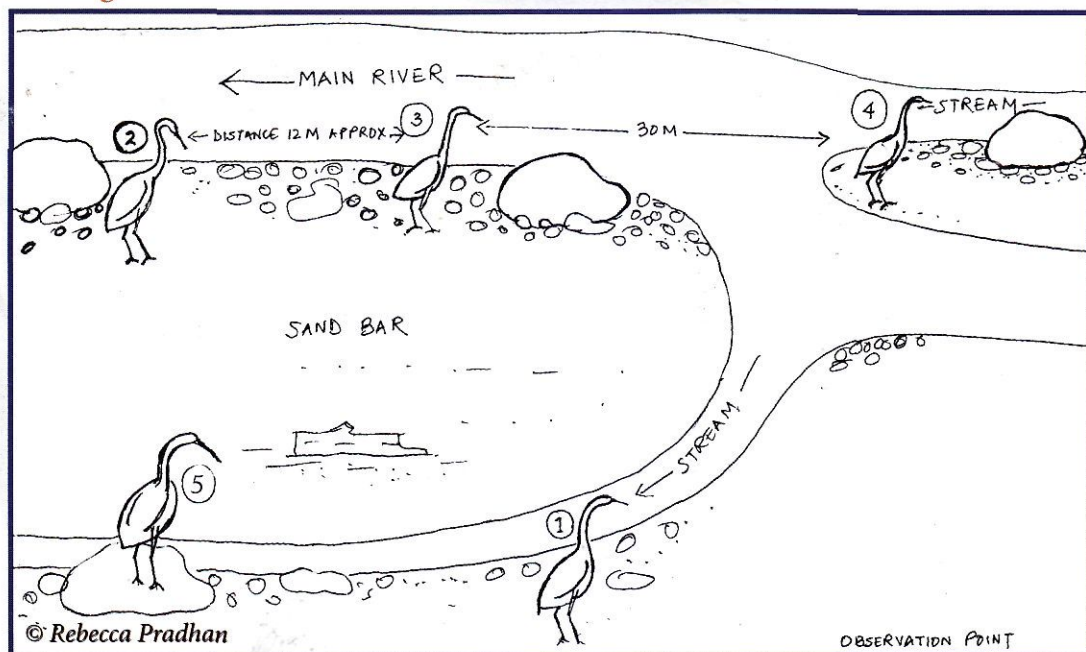
*Adult Heron, Basochhu, Wangduephodrang*



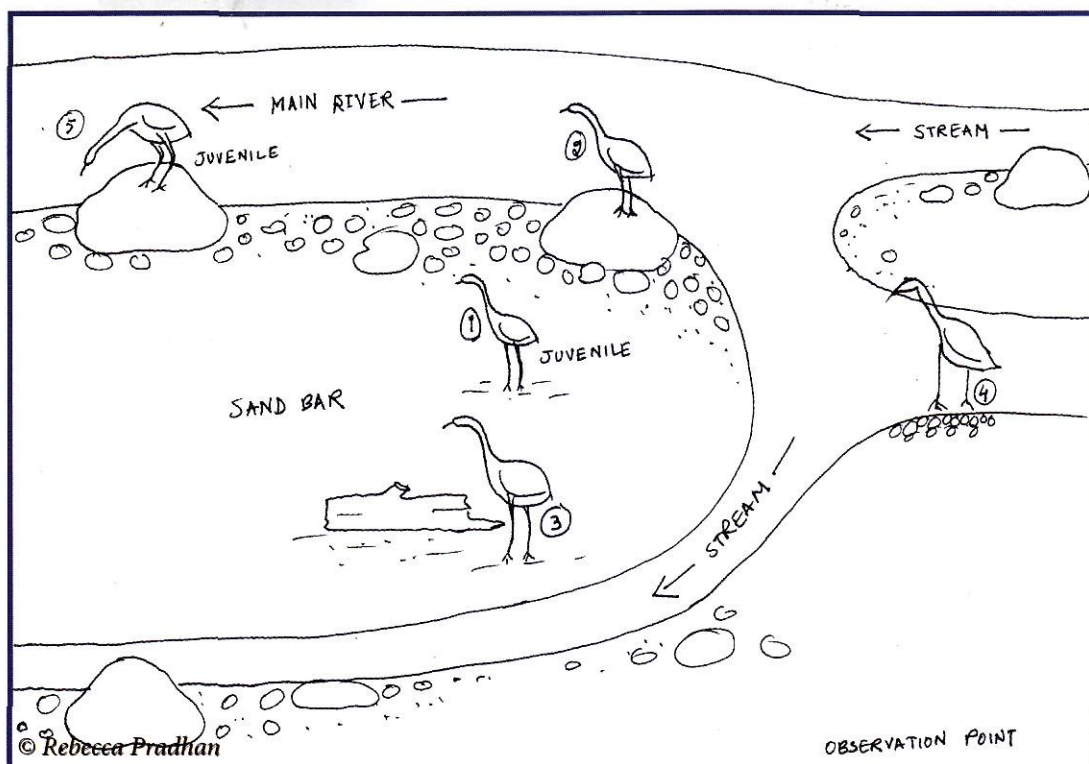




**Figure 3. Field observations of White-bellied Herons basking in Tshek-hathang**

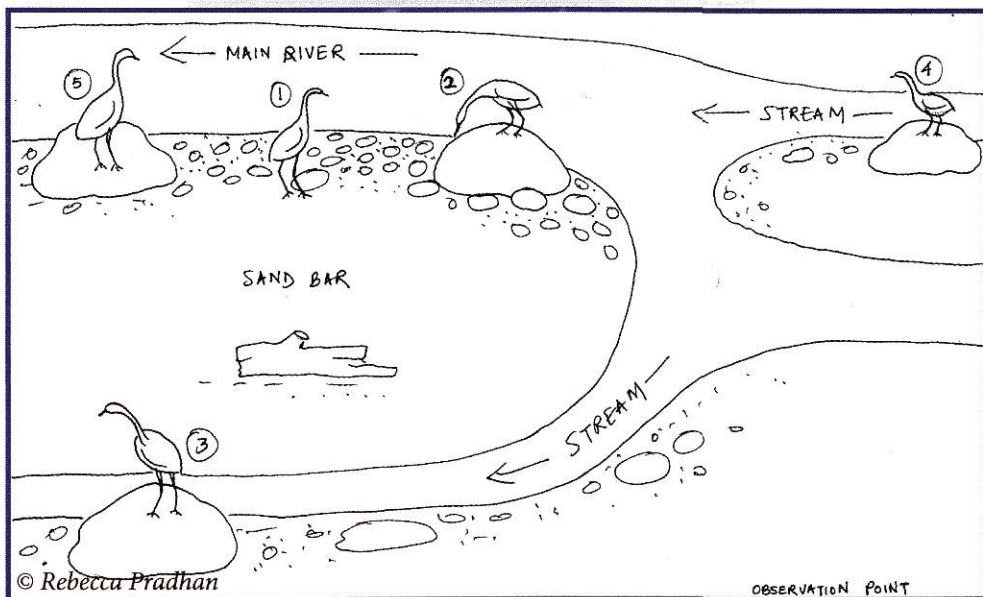


**Basking : 9 A.M. to 10 : 54 AM at Tshekhatang, 31st January, 2007**



**Basking : 11 AM to 11 : 14 AM at Tshekhatang, 31st January, 2007**





**Basking : 11:16 AM to 2 : 30 PM at Tshekhang,  
31st January, 2007**

### *Roosting behavior*

From October to January, White-bellied Herons often roost during the day on cobble and sand bars within the river courses. Roosting was most frequent after 08:30 am when the sun reached the river bar, and herons could often be found roosting for long periods during the middle of the day. Roost sites included large rocks, logs and trees, and often bare sandy patches on the ground. Roosting bars were very open with only large rocks, logs and occasional sparse low-growing clumps of grass or shrubs. White-bellied Herons roosted with neck hunched, or partially recumbent, resting on the tarsometatarsi. In 6 instances we observed birds lay down on the sternum in an incubation-like posture, usually on sand or fine gravel but in one instance on a rock. Usually White-bellied Heron start roosting on trees in the beginning of February after 9 am when the surrounding temperature begins to rise. They can stand still for 5 to 6 hours in one position on the tree. After 2.30 pm or 3 pm when the temperature starts cooling down, they fly down to the feeding sites. During the breeding season, we also noted roosting by the member of the pair not attending the nest on a nearby tree (<200 m distant) or on conspicuous rocks or tree above the river (up to 350 m from the nest).

Nocturnal behavior remains poorly understood. We observed herons on the Phochu flying to a roost site on a nearby hill during twilight, and confirmed the roost site by identifying feathers found on the ground under-



neath roost trees. This roost site was approximately 1 km (straight line) from the closest edge of the river, and approximately 200 m from the edge of open paddy fields that adjoined the river on slopes that ranged from 30 – 40 degrees. Roost trees were located in an open heavily grazed forest dominated by Chir Pine (*Pinus roxburghii*) and roost trees were clearly the tallest trees in the stand, located approximately 300 m from the top of a ridge. The three roost trees were 10, 14, and 16 m in height, and inter-roost tree distances ranged between 52 and 105 m, with little or no mid-story or understory vegetation. The site is regularly grazed by cattle, and, based on local information and fire scars on trunks, is subject to fires of unknown frequency. Distances from roost trees to nearest overstory trees ranged between 8 and 14 m, ( $x = 10.03$ ,  $s.d. = 2.96$ ,  $n = 13$ ). Based on whitewash locations, most birds were roosting near the ends of relatively large lateral branches between 8 and 10 meters above ground level.

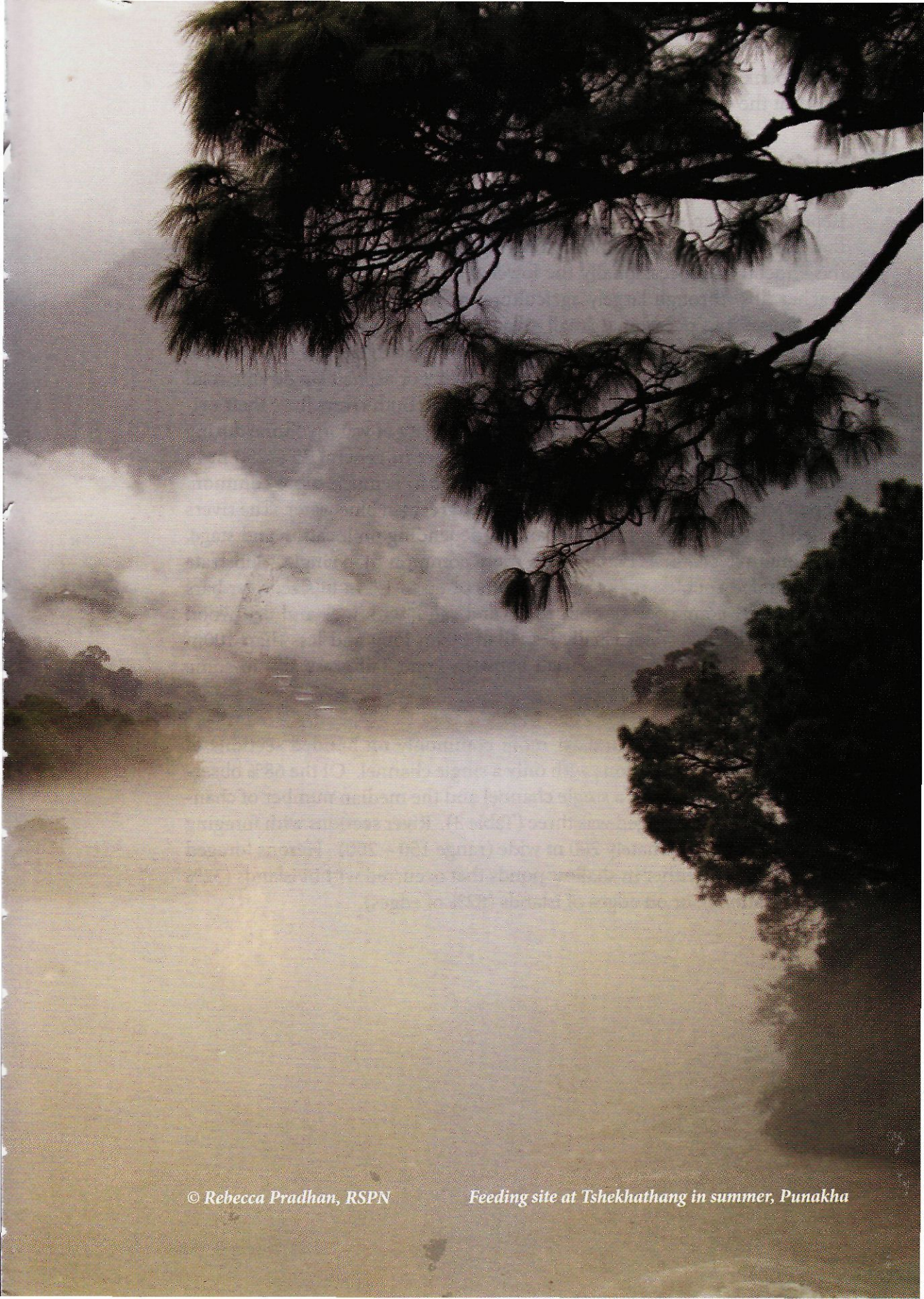
### *Nocturnal hunting*

Some herons and other sight- and tactile-foraging ciconiiform birds are known to hunt at night, probably depending on moon phase (Butler 1992, Bryan et al. 2001, Black and Collopy 1982). We have little evidence for or against nocturnal hunting in the White-bellied Heron. We did not see herons on the foraging grounds on moonlit nights, but we might easily have missed herons at the distances we were observing. On the mornings following several clear, moonlit nights, we did observe that herons on the Phochu either roosted earlier than usual in the day, or seemed to have shorter foraging sessions and apparently less motivation to hunt during the day. However, this is weak evidence either way for nocturnal hunting, and we consider the question of nocturnal hunting to be unsettled.

### *Bathing behavior*

Bathing was observed on six occasions during the winter foraging observations and twice during observations of breeding birds. Herons did not appear to bathe every day during the winter, and when they did so it was between 9 am and 1 pm, when the sun was shining directly on bathing sites. White-bellied Herons usually began bathing by walking slowly into the water until belly and eventually lower parts of the wing were submerged. This was followed on three occasions by forcing the tail into the water so that the body was oriented nearly vertically. Both belly dipping and tail dipping positions were held for many minutes at a time, and were then followed by flapping wings in the water and dipping the head and neck quickly into the water. Following 3 – 10 minutes of bathing in the water, herons would walk







to the bank and rouse several times, and then preen for up to 45 minutes either at the water's edge or on a log, rock or other roosting site.

### *Foraging habitat*

Repeated winter surveys of the rivers of central Bhutan demonstrated that White-bellied Herons were foraging reliably on the lower reaches of the Phochu, and occasionally the lower 8 km of the Mochu. These rivers reaches flow through largely agricultural or forested land, with scattered farmhouses and occasional small villages (2 – 10 houses) within 2 km of the river edge. Both rivers have Chir Pine forests with trees of 20 – 80 years of age on one or occasionally both edges. A dirt or asphalt single lane road borders both rivers at distances of 100 – 700 m. Both rivers have their origins in high altitude glacial lakes, and the majority of water volume during the winter is from this source. These rivers are in general 75 – 250 m in width, and up to 3 m in depth, though 0.1 – 2 m is much more common. Rapids vary between class 1 – 3 with turbid, greenish blue water. The rivers varied between having 1 and 4 channels depending on location and stage, with multiple channels being much more common than single. Substrate was rounded cobbles, rocks and boulders of up to 1.5 m in size; river bars were usually composed of both rocks and sand, with logs and driftwood common. Islands were usually less than 300m long and less than 100m wide; vegetation on islands varied between none, tall grass and in some cases large (10m height) trees.

Foraging herons were found far more commonly on braided sections of these rivers than on sections with only a single channel. Of the 68% observations, only one was on a single channel and the median number of channels where herons foraged was three (Table 3). River sections with foraging herons were approximately 200 m wide (range 150 – 200). Herons foraged most commonly either in shallow ponds that occurred within islands (32% of observations), or on edges of islands (82% of edges).



	Mean	s.d.	median	number	% of observations
River width	198.53	8.511			
Number of islands	2.92	0.359	3		
Channel order	2.32	0.785	3		
<b>Foraging location</b>					
in stream				16	28.6
in isolated pond				18	32.1
n edge of stream				22	39.3
<b>At edge of</b>					
Island				51	82.3
River				11	17.7
<b>water surface</b>					
Smooth				39	62.9
Riffles				18	29.0
Rapids				5	8.1
<b>foraging depth</b>					
Ankle				14	27.5
TMT joint				30	58.8
Thigh				2	3.9
Belly				5	9.8

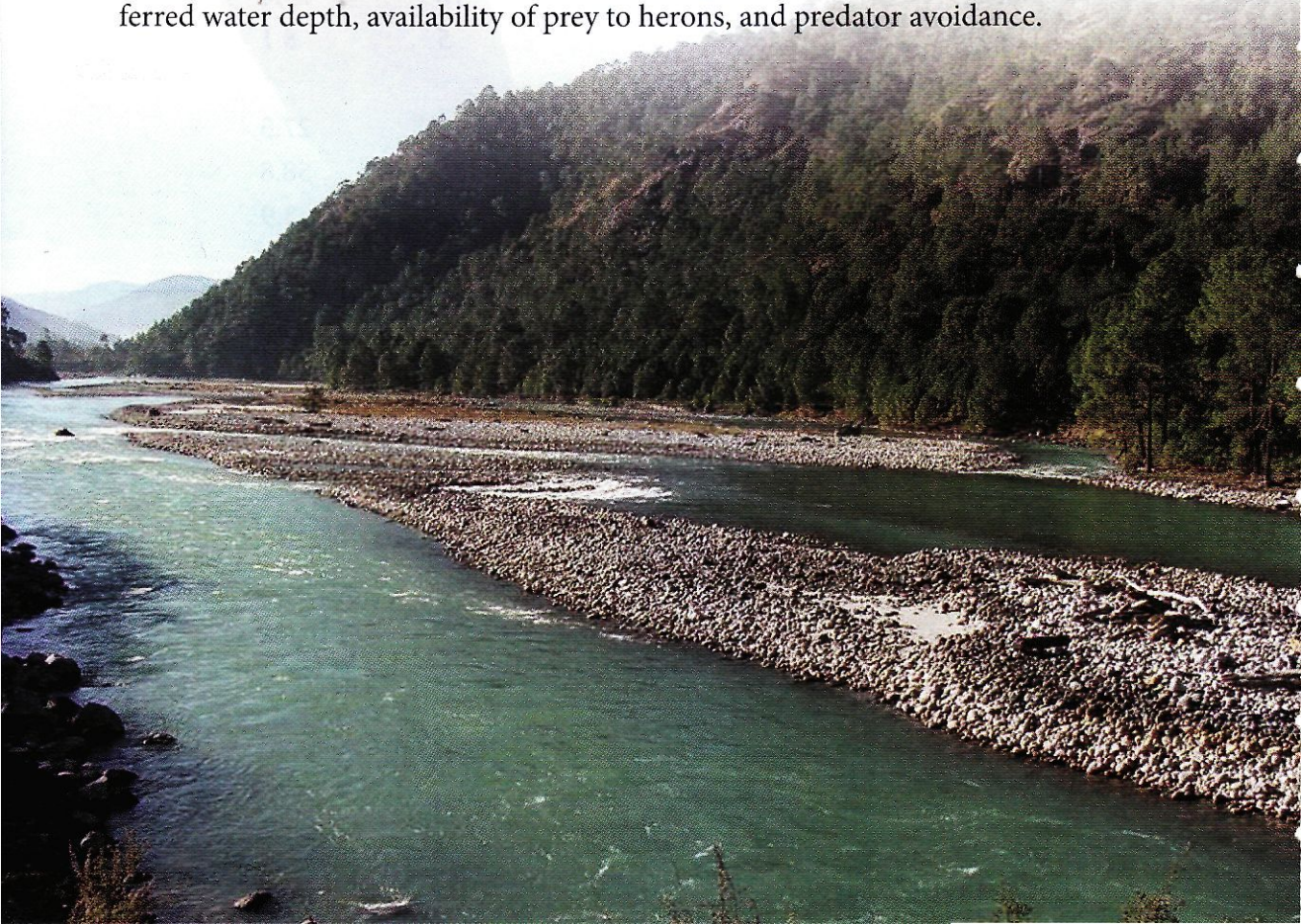
*Table 3. Characteristics of 68 foraging locations of White-bellied Herons in November through January 2007, Pho Chu and Mo Chu rivers, West-central Bhutan*



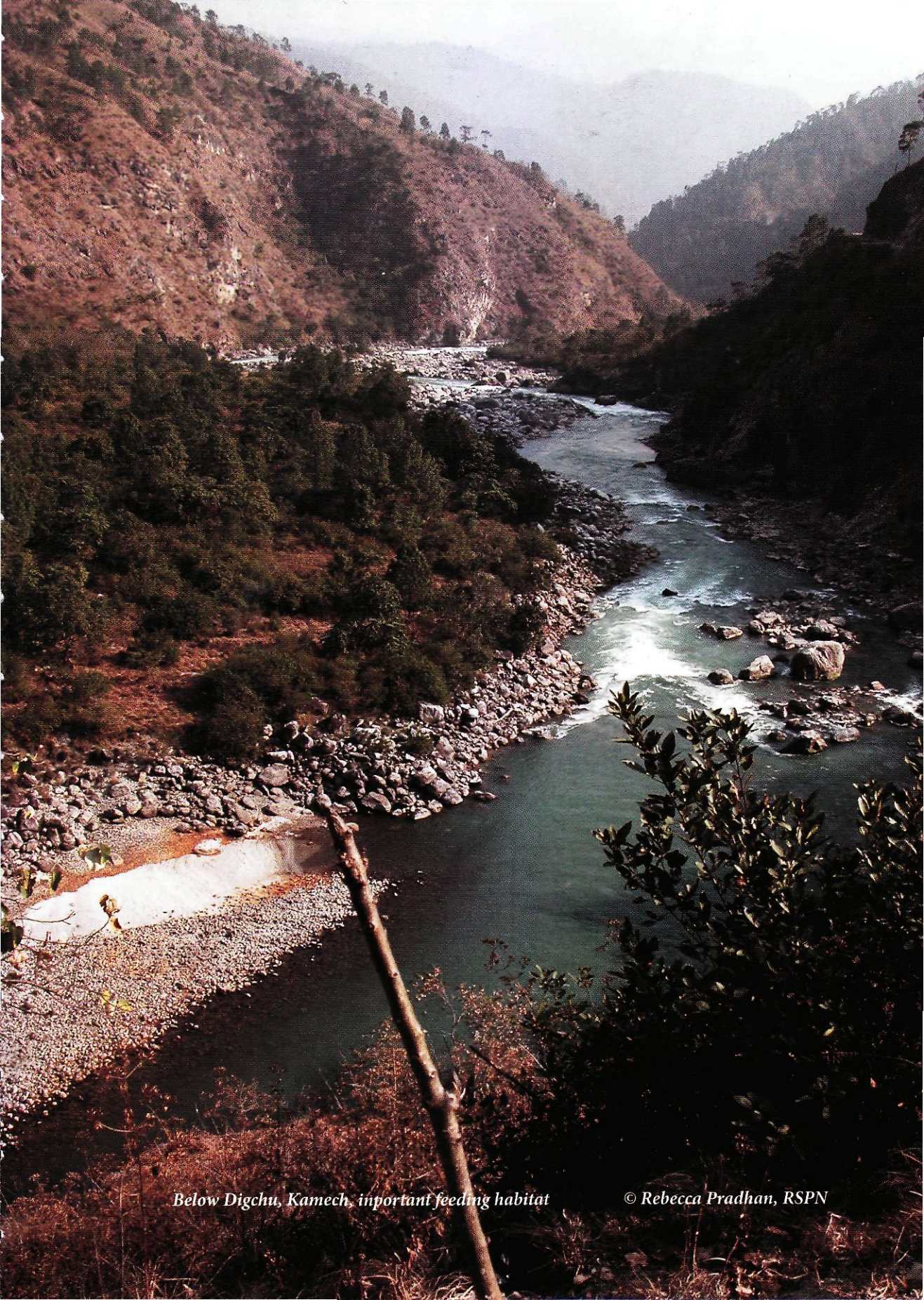
Cobble and gravel islands and multiple channels within the river therefore seemed to be strongly preferred by herons. This preference probably has several sources. First, when the river is divided into multiple channels, the strength of flow and depth in any channel is reduced. This satisfies the need for foraging in relatively shallow water – 86% of foraging observations were of herons in water that did not exceed the tarsometatarsal (TMT) joint. In addition, herons seemed to prefer smooth water (69% of observations) and riffles (29%), and rarely ventured into main flow-ways or even the edges of major rapids. It seems likely that this preference is related both to the need for relatively shallow water, and the need for conditions that allow visual sighting of prey in water.

Smooth, shallow water was only available in ponds and pools contained within bars, and in backwaters and oxbows on the river edges. White-bellied Herons seemed to avoid mainstream river edges strongly, probably because river edges may allow the close approach of potential mammalian predators. Island like sand bars therefore probably offer the additional advantage of a clear field of view of potential predators, and large distances between herons and potential predators and disturbances.

In sum, foraging habitat and microhabitat for herons seems to be related to multiple channels and associated sand bars, probably for reasons of preferred water depth, availability of prey to herons, and predator avoidance.







*Below Digchu, Kamech, important feeding habitat*

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## V. Nesting Ecology

### *Nest locations, success and annual variation in numbers*

The first White-bellied Heron nest was found in Zawa in 2003. Likewise, interviews with local residents of Ada Lake strongly suggest that at least one pair was reproductive in that area some years prior to the discovery of the first nest. Since then, a total of 11 nest sites and 15 nesting attempts were discovered between 2003 and 2009. Almost all the White-bellied Heron nesting sites were found in Wangdue Dzongkhag with one nest in Zhemgang Dzongkhag. Nest sites that have been repeatedly used included Zawa, Ada, Kisonachu, Hararongchu and Bertichu (*Table 1*). Some nest structures were used up to three years in a row before being abandoned. Other sites were apparently used only once before changing to a new tree or site. The reason for changing nest site locations is often unclear. In one case (Hararongchu 2007), the nest was nearly destroyed by forest fire, and the nest was not used in the ensuing year. In another (Basachu 2008), the nest probably did not form because one member of the pair had died in a collision with a powerline during the previous year (see under Threats). Since a number of nest sites were used in consecutive years, we suggest the simplest explanation is that the same adults are using the nest site annually, and that the normal nesting pattern is to attempt reproduction annually. However, our study involved relatively few nests, and it remains unclear whether White-bellied Herons typically occupy nest sites continuously for long periods, or whether nest site turnover is naturally high. Among large herons, egrets and storks, there is large variation in nest site fidelity.

Of the fifteen nest initiations studied, only four failed prior to fledging young (27%). This suggests a relatively high rate of nest success relative to other herons and storks. Of the four failures, one (Hararongchu 2007) was due to a forest fire that burned up to the nest, though the nest tree and nest itself was not consumed. Another two (Ada and Hararongchu 2009) were abandoned during a period of unseasonably heavy rains in May. During the storm, two nests at Kisonchu lost a chick each. No particular cause of failure could be attributed to the fourth case (Zawa 2007), in which an empty nest was found on 29 March 2007. It was unclear whether the abandonment was before or after the disappearance of eggs, and therefore difficult to authenticate whether the disappearance of eggs was due to a predator or scavenger. The Zawa nest is surrounded by relatively dense vegetation and mid-story trees as compared to other nests, and it is possible that this facilitated access to the nest by a climbing predator.



Between one and four eggs were laid in nests, and since young hatched asynchronously, incubation is inferred to begin at the laying of the first egg, as is typical for ciconiiform birds. Mean chicks hatched per nest start was 1.75 (s.d. 0.683). Fledglings per nest start varied between 0 and 3, and averaged 1.25 (s.d. 0.931;  $n = 15$ ). The difference in these two measures suggests that approximately 0.5 chicks may be lost on average between hatching and fledging, which may occur because the entire brood is lost (Zawa 2007), or because a single chick dies (Kisonachu 2007, 2009). As is typical for herons, the youngest or at least the smallest chick seemed most likely to die during this time.

## *Courtship*

Courtship started by the end of January and February along the Punatsangchu main stem. Males approach females, picking up small twigs and throwing them repeatedly. Males and females also peck in the water as if they caught a fish. Such activities are performed several times a day, and may last for one or two weeks. While basking on sand or trees, a pair may also rub their necks together gently and make frequent courtship call. Even while nesting they show their affection to each other by preening and touching. Nest building is begun as early as the last week of February, though there is clearly considerable variation in initiation date (Appendix 4), with first and last nest initiation dates spanning 94 calendar days. Youngs were hatched in the first week of May. Mean time from hatching to fledging was 50 days (s.d. 21.48 days).





*Table 5. Overview of the breeding*

Year	2003	2004	2005	2006	2007	2008	2009	2010	Total	Mean	S.D.
Number of Breeding Female	1	1	1	4	4	2	4	3	20	2.5	1.41
Number of Egg laid	2	3	2	9	12	2	8	7	45	5.62	3.88
Number of Chicks Hatched	2	3	2	9	7	2	6	5	36	4.5	2.67
Egg not Hatched	0	0	0	0	5	0	2	2	9	1.12	1.8
Chick Mortality	0	0	0	3	1	0	1	5	10	1.25	1.83
Fledged Chicks	2	3	2	6	6	0	5	0	24	3	2.44





## *Incubation*

Incubation takes thirty to thirty one days. Both adults incubate, taking turns, and eggs are typically rolled and examined at nest exchanges. Hatching is asynchronous, with 1 – 3 days between the hatching of successive eggs.

For the first fifteen days adults alternately incubate for 2 – 2.5 hours at a stretch. After fifteen days the adults alternately incubate for longer period, up to 3 - 4 hours. During incubation, there is no movement, only their crest flutter in the wind. After fifteen days, we noted that the eggs were rolled towards the direction of the sun and nest was rearranged before sitting on the eggs. Once in a while it stretched its legs and wings. The average nest exchange time is about 3 – 4 hours. We frequently observed adults standing up about 5 minutes before the mate arrived for a nest exchange, and it seemed possible that there may be some long distance vocalization that alerts the incubating parent of impending return of its mate.

## *Fledging period*

As with other herons, attendance at the nest changes markedly with age of chick, with near complete brooding in the first week. Feeding frequency is variable; probably depending on the time it takes parents to catch fish. When the chicks are five weeks old, adults spend much less time on the nest and chicks are typically fed only once per day. By seven weeks, chicks are left alone in the nest while both the parents feed in the nearby stream or river. Nestlings become flight-capable and leave the nest within 72 – 74 days of hatching. In 2004, one brood fledged in 62 – 64 days. Parents did not permanently leave the nest until all chicks have fledged.

## *Feeding*

During the first week, chicks appear to be fed with a semi-liquid predigested food from the parent's bill. A parent opens its bill gape and the young feed from within. By the second week, small regurgitated fish is fed to the chicks. Between 2 – 5 weeks, we recorded chicks being fed twice a day with ten to fifteen fishes received by each chick at each feeding, sometimes by 'scissoring' and sometimes by direct regurgitation onto the floor of the nest. After five weeks chicks were fed once a day in the morning with medium sized fishes, 12.5 - 20 cm, regurgitated directly into the chick's bill.

Our observations for over eight years suggest that the White-bellied Heron





*Footprint of White-bellied Herons on the  
sand below Sunkosh gaon*

© Rebecca Pradhan RSPN







## *Incubation Period*

During the incubation period, the male and female herons would take turns to sit on the nest so one could go out for feeding. The herons would fly south for feeding. A few days later, one of the herons was sighted feeding at the Punatsangchu.

One of the heron has a lighter gray body and is slightly smaller. This could be the female, since it spends more time on the nest. The male has a darker gray body and is bigger than the female.

The heron (either male or female) would perch on the nest motionlessly with only its crest fluttering in the wind. However, about every 20-25 minutes, it would stand up, stretch its wings and work on fortifying the nest. During this period, no calls were recorded. It could be that they did not want predators to locate the nest. The exact period of incubation could not be recorded since the eggs had already been laid when we received news about the nest. After interviewing Ap Sangay Dorji, the first person to sight the nest, we made an estimate of roughly 12-14 days.

## *Hatching*

On 29th April, the first egg hatched. On close observation through a spotting scope, a young chick could be seen. It was only at this time that a second egg was spotted which had not yet hatched.

## *'Cheychey', The Heron Chick*

The following is a week by week update on the development and growth of the heron chick, appropriately named 'Cheychey' by RSPN Researchers.

### *First Week*

Body and head whitish, started feeding from the fifth day (4th May 2003). The parent heron perches on the nest and regurgitates fishes from its stomach. The chick then inserts its head inside the mouth of the parent and takes out the half digested fish. It was observed that during a single feeding session, the parent regurgitates as many as 9-10 fishes to feed the chick.

### *Third Week*

Body and head whitish, beak black, belly yellowish, leg pinkish, crest dis-



tinct, the bird has started flapping its wings but has not ventured out of the nest.

### *Fifth Week*

Legs still whitish unlike the darkish gray/black legs of the adults. Chick growing very fast. It has started flapping its wings more frequently but still has not ventured out of the nest. It also keeps opening and closing its beak. The parents stay at the nest only when feeding the chick. Other times they alight on a different branch of the same tree.

### *Sixth Week*

The frequency of feeding has decreased. The chick is fed only once a day in the morning with 9-10 fishes.

On 12th June 2003 (45 days after hatching). The herons went out together for feeding, leaving the chick unguarded for the first time.

### *Seventh & Eight Week*

The herons have started leaving the chick unguarded quite frequently. Whenever the herons fly out of the nest, the chick flaps its wings vigorously but does not get out of the nest. It could be that the parents are now encouraging the chick to venture out of the nest.

### *Nine & Tenth Week*

Cheychey almost looks like an adult though it is still smaller than its parents and the neck is quite short. The legs are still whitish.

On 1st July (63 days after hatching), the chick finally managed to fly out of the nest and stand unsteadily on an adjacent branch. Every once in a while it would take the support of the tree trunk. During this time, the mother kept flying excitedly from one tree to another tree. The next two days saw the chick venturing out further and further, but to branches of the same tree. It would stand unsteadily on a branch, sometimes unguarded for hours, and the adults would come to the nest only in the evening.

On 4th July (66 days after hatching), the chick flew to nearby tree. The following days it flew frequently from branch to branch and sometimes to



nearby trees. But it was still weak and unable to fly long distances. Every evening the chick would fly back to its nest.

### *Eleventh Week*

Cheychey has started becoming bigger and stronger. It no longer takes the support of the tree trunk while alighting on a branch. It is also flying longer distances but has not flown away from the breeding area.

On 8th July (70 days after hatching), the chick flew south with its parents for the first time, towards their feeding habitat at Digchu. The heron family flies in a single file, following one another. They returned only late in the evening. The next day also they left early and returned late in the evening.

On 10th July (72 days after hatching), Cheychey and family finally left the nest. During the early hours of the morning, they flew south towards their usual feeding grounds but did not return to their nest in the evening. On the morning of 11th July, the heron family was not sighted anywhere in the nesting area. After a week long vigil at the nesting area, it was confirmed that the heron family had migrated to another habitat.

### *Where did Cheychey and his/her family go?*

After considering the various heron habitats in the area and going over their routes on a map, surveys were conducted along the river shores of Pho chu & Mo chu, Hokotsho Lake in Punakha, Samtengang Lake and Ada Lake in Wangduephodrang. No heron were sighted in the first three places but in Ada Lake, 2 herons were spotted. The researcher was of the speculation that the family had abandoned Cheychey to fend for itself. However, after a few days, the heron family was spotted flying North from the breeding area. This means that the heron at Ada Lake was not Cheychey's family. The 2 heron from Ada Lake could be the ones that was sighted along the river shores of Pho chu in April. The heron family might still be roosting somewhere in the breeding area.

The Researchers were stationed at Ada Lake, keeping vigil on the two herons and also trying to track Cheychey's family and locate their roost.

The first heron study was conducted along the Pho chhu river (alt:1290m). 4 herons had been reported in the area by residents and forestry officials. However, during the field study, only 2 herons were spotted feeding along the Pho-chhu river, shore. Remains (only a few feathers) of a dead heron



was also found. According to the Forest guard of Punakha Range Office, the heron had died about two weeks ago and some labourers had thrown it into the river. The cause of death was unknown though the residents claimed that it might have died a natural death. This might have been the third heron, whose partner had left the area after its death. When asked about the migratory patterns, the resident said that they see the birds from October to April and they have no idea where they go for the rest of the year.

### *September 2004 (Second Heron Nest in Bhutan)*

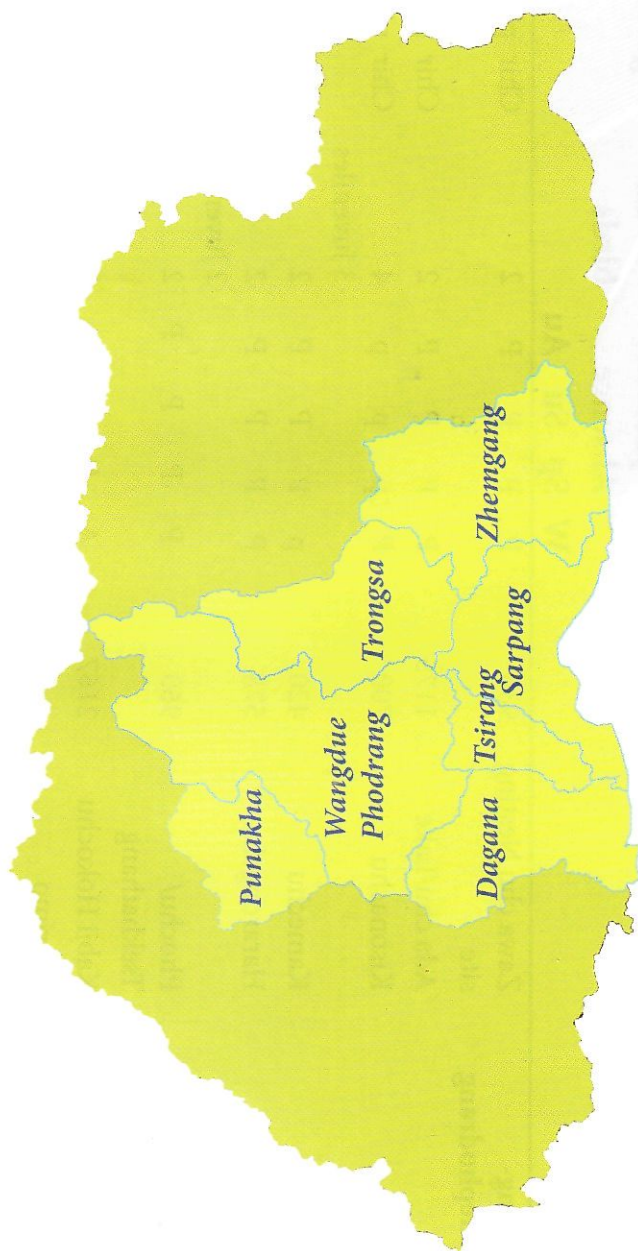
Another significant finding was the discovery of a second heron nest. The nest was located in the vicinity of last year's nest. Although the nest was not discovered during its hatching period, we were able to get vital information and confirm some of the previous observations.



## Appendix II

Locations where WBH have been sighted in the Central Zone of Bhutan. Numbers of birds indicates number of birds regularly found; "O" indicates occasional sightings. Note that since this information comes from different years and survey efforts, birds could certainly move between localities. Total numbers of birds seen is therefore an overestimate of population size in Bhutan. Seasons of presence/absence are Winter (W), Spring (Sp), Summer (Su) and Autumn (Au).

### *Central Zone of Bhutan*





Dzongkhag	Place / Rivers Name	Altitude (m)	Bird presence / Absence				No. of birds	Vegetation Type
			W	Sp	Su	Au		
Wang- duephodrang	Zawa chu Nesting site	930	P	P	P	P	2	Chir pine
	Ada chu/Lake	1175	P	P	P	P	2	Chir pine
	Kisonachu	700	P	p	p	p	4	Chir pine
							3 Juveniles	
	Kamechu	420	p	P	P	P	2	Chir pine / Broad-leaf
Punakha	Hararongchu	578	P	P	P	P	2	
							2 Juveniles	
	Phochu/ Tsekhathang	960	P	P	P	P	2	Chir pine
	Kabji Hokochu	2167	A	A	A	A	0	Br-leaved
	Amrimo		O	A	A	A	0	Br-leaved
	Mochu Sonagatsa	1237	P	P	P	P	2	Chir pine/ Br-leaved
	Phochu Mochu confluence		P	P	P	P	2	Chir pine/ Br-leaved



<b>Dagana</b>	Khagochin chu	534m	A	A	A	A	0	Chir pine
	Daga chu	587m	O	A	A	A	0	Chir pine/ Br-leaved
	Bitlung chu	897m	A	A	A	A	0	Chir pine/ Br-leaved
	Cherichu	390m	A	P	P	A	2	Chir pine
	Sunkosh river opposite Salamji village	386m	P	P	P	P	1	Br-leaved/ Chir pine
<b>Tsirang</b>	Buri chu		O	A	A	O	0	Br-leaved/ Chir pine
	Sunkosh		O	A	A	O	0	Br-leaved/ Chirpine
<b>Geleyphug</b>	Mou khola /	318m	A	A	A	A	0	Br-leaved plantation
	Shersong chu/	245m	A	A	A	A	0	Br-leaved
	Tato pani	323m	A	A	A	A	0	Br-leaved & orange or- chard
<b>Trongsa</b>	Loring Chu	1134m	A	A	A	A	0	Br-leaved
	Phhechu	1115m	A	A	A	A	0	Br-leaved/ Chirpine
	Khirsu chu	1217m	A	A	A	A	0	Br-leaved/ Chirpine
	Korphu chu	1500m	A	A	A	A	0	Br-leaved/ Chirpine
	Zhiligang chu	1220m	A	A	A	A	0	Chir pine
	T/sa Mangde chu	915m	A	A	A	A	0	Br-leaved/ Chirpine



Zhemgang	Berti chu	645m	P	P	P	P	5	Chir pine
	Yangderchu	534m	O	A	A	O	0	Br-leaved/ Chirpine
	Magdechu	570m	P	P	A	P	1	Br-leaved/ Chirpine
	Kikhar chhu /Man-gdechu	1495m	A	A	A	A	0	Br-leaved
	Gongphu road (Mangdechu)		A	A	A	O	0	Chir pine
	Chandang chu	1125m	A	A	A	A	0	Br-leaved/ Chirpine
	Chandangong Chu	810m	A	A	A	A	0	Br-leaved/ Chirpine
	Duenmang chu	450m	A	A	A	A	0	Br-leaved/ Chirpine
	Zaiga chu	795m	A	A	A	A	0	Br-leaved/ Chirpine
	Rongdigang chu	1170m	A	A	A	A	0	Br-leaved/ Chirpine
	Chamkarchu chu	1300m	A	A	A	A	0	

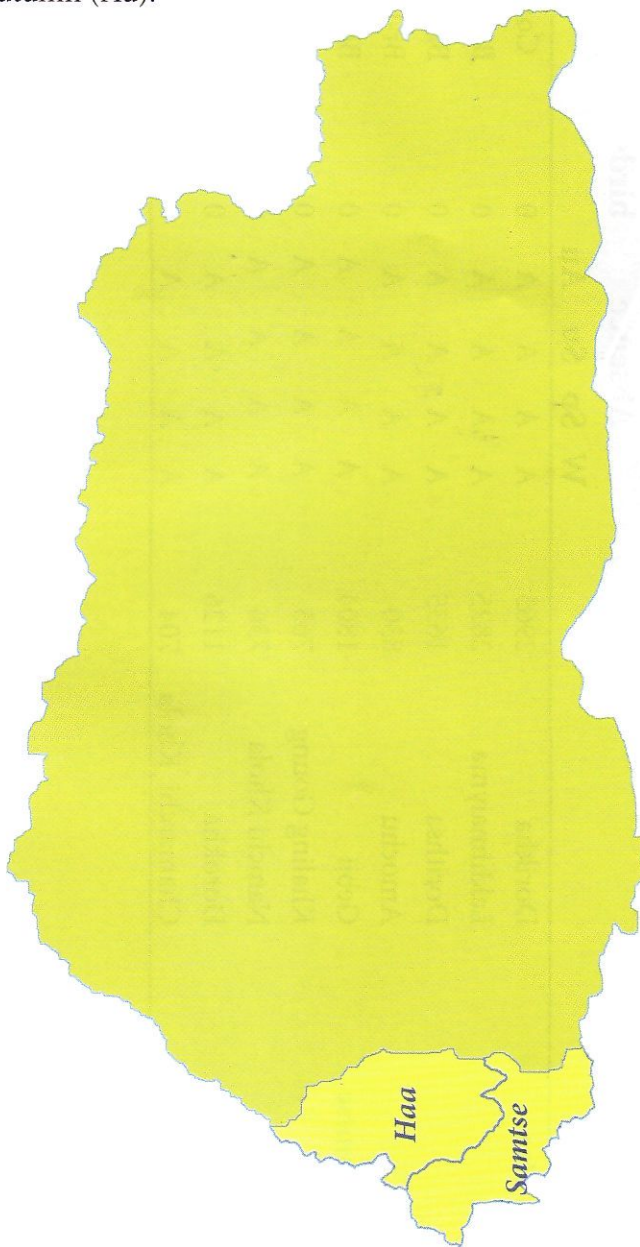
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## Appendix III

Locations where WBH have been sighted in the Western Zone of Bhutan. Numbers of birds indicates number of birds regularly found; "O" indicates occasional sightings. Note that since this information comes from different years and survey efforts, birds could certainly move between localities. Total numbers of birds seen is therefore an overestimate of population size in Bhutan. Seasons of presence/absence are Winter (W), Spring (Sp), Summer (Su) and Autumn (Au).

### *Western Zone of Bhutan*





Dzongkhag	Place / Rivers Name	Altitude (m)	Census Remarks					
			Bird presence / Absence				No. of birds	Vegetation Type
			W	Sp	Su	Au		
Haa	Dorikha	2965	A	A	A	A	0	Conifer/ Br-leaved
	Lakhimaiyma	2825	A	A	A	A	0	Br-leaved
	Dorithsa	1635	A	A	A	A	0	Br-leaved
	Amochu	830	A	A	A	A	0	Br-leaved
Samtse	Gebji	1804	A	A	A	A	0	Bl-leaved
	Khaling Goung	765	A	A	A	A	0	Bl-leaved
	Namchi Khola	736	A	A	A	A	0	Bl-leaved
	Dorokha	1126	A	A	A	A	0	Bl-leaved
	Chamarchi Khola	704	A	A	A	A	0	Bl-leaved



## Appendix IV

Locations where WBH have been sighted in the Eastern Zone of Bhutan. Numbers of birds indicates number of birds regularly found; "O" indicates occasional sightings. Note that since this information comes from different years and survey efforts, birds could certainly move between localities. Total numbers of birds seen is therefore an overestimate of population size in Bhutan. Seasons of presence/absence are Winter (W), Spring (Sp), Summer (Su) and Autumn (Au).





Dzongkhag	Place / Rivers Name	Altitude (m)	Census Remarks					
			Bird presence / Absence				No. of. birds	Vegetation Type
			W	Sp	Su	Au		
Monger	Shongar chu/Mauri	685	A	A	A	A	0	Br-leaved/Chir Pine
	Chhang khyo chhu	875	A	A	A	A	0	Chir Pine
	Gangla ri	1178	A	A	A	A	0	Br-leaved/ Chir Pine
	Diwang chu	848	A	A	A	A	0	Br-leaved/ Chir Pine
	Toka ri	643	A	A	A	A	0	Br-leaved/ Chir Pine
	Chhimung chu	771	A	A	A	A	0	Br-leaved/ Chir Pine
	Wabrag chhu	923	A	A	A	A	0	Br-leaved/ Chir Pine
	Shemkhi Chhu	1296	A	A	A	A	0	Br-leaved/ Chir Pine
	Gong Ri	582	A	A	A	A	0	Br-leaved/ Chir Pine
	Radi chhu	930	A	A	A	A	0	Br-leaved/ Chir Pine
Trashigang	Bhagong Ri	784	A	A	A	A	0	Br-leaved/ Chir Pine
	Dangme chhu	900	A	A	A	A	0	Br-leaved/ Chir Pine
	Gam ri	1051	A	A	A	A	0	Br-leaved/ Chir Pine
	Gam ri	434	A	A	A	A	0	Br-leaved/ Chir Pine
	Gam ri	1468	A	A	A	A	0	Br-leaved/ Chir Pine



	Gam ri	948	A	A	A	A	0	Br-leaved/ Chir Pine
	Chukha ri	1318	A	A	A	A	0	Br-leaved/ Chir Pine
	Kheng Ri	1010	A	A	A	A	0	Br-leaved/ Chir Pine
Trashiyangtse	Jamkhar bridge	778	A	A	A	A	0	Br-leaved/ Chir Pine

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Place Name	Year	Hatching Date	No. of Chicks Hatched	Fledging Date	No. of Fledging Chicks	Chick Mortality No./Date	Years Nest Used	Remark
Zawa	2005	15th March	2	23rd May	2	-	2	
Zawa	2006	19th March	3	30th May	2	1		
26 May	3							
Harachu	2006		2			2		
21 May	new							
Berti	2006		2	1st June	2	-	-	
Cerichu	2006		2	4st June	2	-	-	
Zawa	2007						4	Abandon due to 2 eggs lost on 29th-March
Harachu	2007		2	-	-	2	1	Abandoned due to forest fire
Berti								

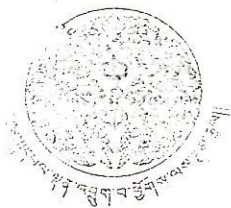


2007			2	2	Old nest	
Basachu	2007	2	7th May07	1		New
						Lost an egg during incubation
Kisona chu	2007	10thMay	2			New
		19thMay	1			
		21stMay	1			
			20th July	2		
			24th July	1	1	4th chick was very weak, died on 25th May





# Appendix VI



རྒྱལ་ཡོངས་འཕྲུལ་འབྲུག་ལྷན་ཁག་

ལྷན་ཁག་གི་འཕྲུལ་འབྲུག་ལྷན་ཁག་

ROYAL GOVERNMENT OF BHUTAN

Cabinet Secretariat  
Tashichho Dzong  
Thimphu : Bhutan

COM/04/07/ 887

March 1, 2007.

Hon'ble Minister  
Ministry of Agriculture

Hon'ble Deputy Minister  
National Environment Commission

**Sub: Environmental impact of Pho-chu and Punatsangchu quarries.**

Your Excellencies,

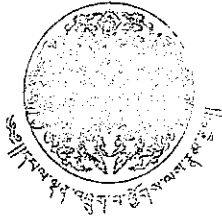
The Government has reviewed the findings of the joint investigation carried out by the National Environment Commission and the Department of Forest, Ministry of Agriculture on boulder and sand quarrying along the Pho-chu and Punatsangchu and their impacts on White-bellied heron habitat. It has been noted that there are two quarrying sites along Pho-chu namely at Gubjithang and Khawaraja, both of which fall within the critical habitat of White-Bellied Heron. There are also other operational and non-operational sites along Pho-chu as well as Punatsangchu including one site at Samdingkhar yet to be operated.

In view of the foregoing, the Government has approved, in principle, the following:

1. Banning all quarrying operations along Pho-chu namely at Gubjithang, Khawaraja and Samdingkhar, and declaring the areas as the protected habitat of white-bellied heron. However, the NEC and MoA should submit the exact details of areas to be protected.
2. Enlisting white-bellied heron in Schedule I of the Nature and Forest Conservation Act 1995 through the National Assembly.

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འབྲུག་རྒྱལ་ཁབ་ཀྱི་རྒྱུ་རྩུབ་ལྷན་ཁག་

ཕྱག་ཁྱེད་ཀྱི་ཚོམས་ལྷན་ཁག་

ROYAL GOVERNMENT OF BHUTAN

Cabinet Secretariat  
Tashichho Dzong  
Thimphu : Bhutan

Further, the joint team of the NEC and Forest Department, MoA has been directed to look into the modalities as to how the agreement between the Dratshang (as Khawaraja and Samdingkhar sites are owned by them) and the Contractors for the quarry can be resolved, in the event quarrying is banned immediately, vis-a-vis the ownership of the minerals on private land in accordance with the Mines and Minerals Management Act 1995. Based on the report, the government will take further course of action. It has also been directed that once a declaration is made, it will be the responsibility of the NEC and NCD, Forest Department to monitor the compliance.

This approval has reference to the 336<sup>th</sup> Coordination Committee Meeting (CCM) Session of the Council of Ministers held on February 6, 2007.

With warm regards,

Yours sincerely,

(Sherub Tenzin)

CABINET SECRETARY

Cc:

1. Hon'ble Prime Minister.
2. All Hon'ble Ministers.
3. Zhung Kalyon, Royal Advisory Council.
4. All Secretaries to the Government.
5. President, Bhutan Chamber of Commerce and Industry.





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